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# LOG DEFECTS

## IN

# SOUTHERN HARDWOODS



Agriculture Handbook No. 4



UNITED STATES DEPARTMENT OF AGRICULTURE  
Forest Service



# Log Defects in Southern Hardwoods



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# Log Defects in Southern Hardwoods<sup>1</sup>

## INTRODUCTION

The appraisal of hardwood timber and grading of hardwood logs has often been classed as a mysterious art, with most of the deep secrets held by old-time timbermen. Even they were not infallible, however, for when moving from one locality to another, many failed to judge timber quality accurately and, as a result, suffered financial reverses. Consequently, the idea developed that there are undistinguishable basic differences in hardwood timber of the same species found in different localities, and that without highly localized experience, appraisal can be no more than a guess. The truth is that although there are important local differences, the factors determining quality are subject to analysis and can be systematically described and universally applied to both standing and felled timber (logs).

There is great need for complete understanding of all the factors affecting hardwood timber quality. Many appraisal problems that low stumpage values for timber of high general quality formerly made relatively unimportant are now becoming pressing and unavoidable. The primary fact here is the recognized general decrease in average level and increase in variability of hardwood timber quality. Perfect trees are rare; cull trees are plentiful. Volume per acre is low and the trees are small. Tree size is especially important because the factors that reduce quality operate much more severely in small timber than in large timber. For example, the same number of overgrown limb stubs are obviously less damaging when scattered through logs averaging 3 or 4 per thousand board feet

than when contained in logs averaging from 6 to 10 per thousand board feet.

Loggers also need a basic understanding of hardwood quality. In log-making in high-priced timber of variable quality, failure to allow for and handle intelligently the factors affecting quality will result in material loss. One especially vital point is determination of the lower limits of merchantability. Today, in hardwoods, it is no longer possible to base merchantability simply on size, straightness, superficial smoothness, and freedom from rot and shake. Merchantability is equally influenced by type, location, and concentration of log defects, including those which are so inconspicuous as to be almost unnoticeable.

Moreover, in order to utilize high-value stumpage most profitably, it is becoming more generally necessary to prepare it for several markets, instead of cutting for only a single use. This means that from a given hardwood tract, logging operations may produce veneer logs, standard sawmill logs, tie and timber logs, logs for low-grade construction lumber, stave bolts, fence posts, pulpwood, and fuel wood. An understanding of quality is essential for such multiple-use logging operations.

One other important need for definition of hardwood quality derives from the strong movement toward scientific forest management. A forester, marking timber under a program designed not only to feed the proper raw material to individual industries but also to maintain and improve the forest growing stock, must know very thoroughly the factors on which quality is judged.

This publication describes what are probably the least well understood of the factors determining log quality—the indicators of defect which appear on the surfaces or ends of the logs.

<sup>1</sup>The term "southern hardwoods" is used not because all species discussed are confined to the South but because, with few exceptions, they are found in greatest abundance or reach their optimum development there. The information applies, however, wherever the species are found.

## FACTORS AFFECTING QUALITY

In order to isolate and examine the basic factors which determine the quality of a log and hence of a tree, it is necessary to set up a standard. A theoretical standard would be a straight, cylindrical tree trunk consisting entirely of absolutely perfect wood. Such a phenomenon is never found in nature, if only because every tree tapers and has a pith center.

A more practical standard for quality comparison is a log with the following specifications:

1. It is a butt log, round or only slightly oval in cross section.
2. It is 16 feet long and about 24 inches or more in diameter at the top end.
3. It is straight, but has a slight taper and a slight butt flare.
4. The wood is straight-grained. There is no requirement as to other characteristics of the wood, i. e., whether heart or sap, uniform or variable in density or color.
5. The log has a "heart center" in a central cylinder whose diameter is not more than 40 percent of the log diameter. This heart center contains limb stubs and pith center only; it is free from rot, shake, stain, and similar imperfections.
6. The wood between the heart center and the bark has no imperfections such as knots, holes, bark pockets, mineral stain, or rot.

Standard products of high value will be cut from such a log. Any deviation from these specifications, except for a moderate one in size, will reduce average value of potential products. The deviations which are most important, occur most frequently, and thus, for all practical purposes, determine quality are (1) change in position of log in tree, (2) reduction in size of log, (3) crookedness, and (4) imperfections in either the heart center (except for knots and pith) or in the outer rim of wood.

*Position* affects quality because the further up the tree the log is, the larger the heart center, relatively, and the coarser the limb stubs in it are apt to be.

*Change in size*, especially in diameter, is very important. A decrease in diameter will cause a rapid increase in the proportion of products containing the coarse heart-center blemishes. If made into standard factory lumber, the logs of the larger diameters will yield wider and more valuable boards; and the wider the boards, the greater the possibility of raising values by primary ripping to eliminate or segregate blemishes. Changes in length are not so important in the individ-

ual log, for highest-grade products permit pieces of all lengths down to 8 feet. However, there are definite limitations on the percentages of short lengths which can be included in large shipments of a given grade, and there is sometimes a premium on shipments containing all long lengths (14 feet and 16 feet).

For logs of a given position and size, *crookedness* is an important cause of reduced product value. There are two variations of this factor. One is "sweep," a gradual curvature or deviation from a straight line drawn from one end of the log to the other. The other is a sharp deviation termed "crook." The immediate effect of either is to bring the low-grade center nearer the surface when the log is sawed. A "cross-grain" effect also appears in the product. Furthermore, sweep and crook sometimes originate from a broken fork or heavy limb and thus may be related to abnormal interior defect. The effect of crookedness on quality is complex, but in all kinds of logs it reduces the value of the product by weakening the wood through the cross-graining effect or by causing an abnormal distribution of blemishes. Besides reducing value, sweep and crook inevitably reduce the volume of the product. They also increase production costs, for crooked logs are hard to handle on rollways, are difficult to fit into loads, and frequently reduce rate of sawing.

Final common deviations take the form of *imperfections in the outer rim of wood or the heart center*. Such imperfections are broadly called "defects." Of all the factors affecting wood quality, they are unquestionably the most important. They fall into two main categories: (1) Those which reduce the volume of sound wood or lower its durability, and (2) those which lower the strength or utility. The first category comprises the so-called scalable defects (chiefly rot, shake, and checks), which are deducted from the gross scale of the log and are normally removed from the product in manufacture. The second includes such things as knots, stains, holes, and bark pockets, which cannot be removed in primary manufacture. Defects of the latter class control the quality of the portion of the log looked to for clear, unblemished pieces of wood and are basic quality determinants where strength or durability or fine appearance is required.

"Defective timber" popularly connotes rotten or overmature trees, even though they contain much usable material. The amount of scalable defect, together with size limitation, is often the main criterion

limiting merchantability of logs or trees. Actually, timber from which cull material (scalable defect) can be removed in manufacture is not necessarily defective: there may be no serious blemishes in the remaining usable wood. On the other hand, perfectly sound trees may be so defective as to be worthless because of scattered degraders which cannot be eliminated in manufacture. Since a defect that reduces volume (e. g., rot) is entirely different from a defect that reduces utility (e. g., knot), it is logical to call scalable defects "cull," and to apply "defect" only to those imperfections that lower the quality of the product into which sound wood in the tree or log will be converted.<sup>2</sup> It is from this viewpoint that defects are discussed herein.

## NATURE OF LOG DEFECTS

Log defects, and product defects too, can be defined and evaluated only in relation to use. Whether a blemish in the wood is a product defect, and whether an indicator of the blemish on the surface or end of a log is a log defect, will be determined by the specifications for the product into which the log is to be manufactured.

For example, mineral streaks would ruin the utility of oak lumber for making fine table tops and thus would be considered defects. They would not, however, affect the strength of a piece to be used as a tie, and for this use would not be regarded as defects. An unsound knot, 2¾ inches in diameter in the middle of a floor joist 2 inches by 8 inches by 16 feet would render the piece useless and hence would be a serious defect. The same knot, in an otherwise clear 16-foot board from which it was desired to cut two 7-foot clear pieces for bed rails, would be a defect only if it prevented the cutting of the required clear pieces. Its degrading effect would be equaled by a sound ¼-inch knot that would pass unnoticed in a floor joist. Actually, for the bed-rail use, the piece would be of the highest recognized grade.

### *Relation of Defects to Use*

Thus, in analyzing the operation of the various factors which determine the quality of a hardwood log, the nature and expected use of the end products must be given prime consideration. Each use has its own technical requirements, which are reflected in varying tolerances for type, number, and distribution of im-

Usage gives the term "defect" to abnormalities on the log surface as well as to imperfections in the wood. These outside features are really indicators of imperfections in the underlying wood, and, strictly speaking, should be termed defect indicators. A branch stub, for example, is an indicator of a knot in the product to be sawed from the log. However, because of usage and because timber appraisals deal with logs as such, this publication terms these surface features "log defects," and distinguishes them from imperfections in the wood by calling the latter "product defects."

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<sup>2</sup> This distinction is not always clear-cut; cull when affecting only small areas may be left in the product, where it impairs strength or utility and thus becomes a defect.

perfections permitted in the wood. The sawmill trade has found over the years, however, that logs can be grouped by major use requirements into three general classifications, namely, those suitable for standard factory lumber, for ties and timbers, and for miscellaneous low-grade or local-use products. In this report, the terms *factory log*, *tie and timber log*, and *local-use log* refer to these basic log-use classes.

It may appear that the discussions in this publication are preoccupied with large sawed products, and that inadequate attention has been given to such products as veneer, cooperage, dimension and handle stock, or other specialties. The fact is that although these items may assume considerable local importance, they are only a minor part in the total picture of hardwood utilization. Probably 90 percent of hardwood timber is cut into the products for the three general uses described. Furthermore, the specifications for specialty products are closely related to those for factory lumber in that relatively short, clear pieces of practically perfect wood or veneer sheets with few defects are desired. It is probable that local studies of specialty products will judge defect significance on about the same bases as those on which factory logs are judged.

*Factory lumber use* is based upon producing lumber which is later to be recut into smaller pieces, free or relatively free from blemishes and imperfections (fig. 1). The value (grade) of such lumber is determined by specifications of the grading rules of the National Hardwood Lumber Association. These specifications control the yield of such high-quality pieces

as can be cut from the original board of a given grade. High-grade boards are those which will yield high percentages of good pieces, with individual ones relatively large. Low grades are those which yield low percentages of such material, generally only in the smaller sizes. The technical base for the grading is the so-called clear-face cutting. This is defined as having one face free from defects and the reverse side sound, which means free from rot, heart center, shake, and wane. Texture is not considered. The sound reverse face will admit certain defects such as sound knots, sound bird peck, stain, streak, or worm holes—imperfections which do not impair the strength of the piece. Tabular statements of basic specifications for factory lumber are found in the appendix, page 35.



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FIGURE 1.—*Factory lumber log.* This type of log is relatively straight and will permit much center defect, but must have wood in outer rim relatively free from blemishes. Blemishes present must be so spaced that certain minimum amounts of defect-free rim wood can be obtained. Distribution, rather than size and character of log defects, is the most important factor.

*Tie and timber use* is that in which the pieces are to be used more or less intact for structural or weight-bearing purposes (fig. 2). Specifications are contained in the National Hardwood Lumber Association's 1943 "Standard specifications for structural-stress grades of hardwoods and cypress," in the tie specifications of the American Railway Engineering Association, and in the standard specifications of the American Society for Testing Materials for structural wood joists and planks, beams and stringers, and posts and timbers. These specifications in general control strength. The position and condition of heart in the piece is especially important. Knots and other defects which would impair the strength are limited to sizes which hold impairment within satisfactory limits. Although



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FIGURE 2.—*Tie and timber log.* This type of log is essentially straight and internally sound, with no rot, splits, or shake admitted. Defects can be numerous if they are scattered and relatively small. Products are judged on strength.

factory lumber grades allow for progressively more defects from the high grades to the low grades, tie and timber specifications are rigid throughout with regard to the inclusion of weakening imperfections. This results in log requirements different from those for factory lumber use. For example, enough high-grade boards can often be taken from the outside of a log with rotten, shaky interior and large but widely spaced individual log surface abnormalities so that average quality of products is high. Such a log might be a cull for tie or timber use.

*Miscellaneous or local-use products* include those uses that are generally not covered by any standard specifications (fig. 3). High strength, great durability, or fine appearance is usually not required. The products are of low value and are mostly sold in local or restricted markets for such purposes as secondary farm buildings, crating, mine ties, industrial blocking, and miscellaneous construction. Whereas the products for the first two classes are usually sold over a wide area through a variety of marketing channels, local-use materials are generally sold direct to the user by the producing mill. Perhaps the highest-value products in this class would be structural boards, as defined in the rules of the National Hardwood Lumber Association.

This system of log classification represents a sort of one-way street. That is, all logs are allocated to the highest class to which they are naturally adapted, regardless of any suitability for the purposes of a lower class. The lowest class as shown by average sale value is local-use logs. None of the logs suitable for local use is also suitable for tie and timber use. Neither

can logs suitable for ties and timbers be economically manufactured into factory lumber. On the other hand, most higher-grade logs can be and often are used for lower-grade purposes. It is common to observe logs best adapted to factory lumber being cut into ties and, vice versa, to see mills producing standard lumber from logs best suited for timbers. At both tie and lumber mills can be found logs unsuited for either type of production. The reasons for this are quite complicated and not due entirely to lack of understanding on the part of operators. One important



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FIGURE 3.—*Local- or miscellaneous-use log.* This type of log, because of size, placement, and character of defects, cull, or crookedness, will yield only small percentages of defect-free rim wood or construction material. It will yield a variety of low-quality items in which strength or appearance is not important.

reason is that there are no accepted specifications covering these three types of logs to guide operators in allocating logs to the most appropriate use.

### *Classes of Log Defects*

Log defects can be divided into two general classes: those found on the surface of the log, and those found on the ends. Beyond this, there can be no general classification. One reason is that, although most of the important blemishes in wood are associated with abnormal features visible on the log surface, some abnormalities do not reflect imperfections in the wood. Furthermore, even though a log abnormality is an indicator of wood blemish, whether or not the blemish is a log defect depends upon the class of log in which it is found, for its effect depends upon the specifications of the products to be made from the log.

In factory lumber logs, the most important wood blemishes are those in the outer rim of wood. Few,

if any, of the indicators of these blemishes can be disregarded. This is true regardless of the size of the blemish. In tie logs, the reverse may be true. In one tie log, size of defect may be the controlling factor; in another, the important defects may be only those unsound ones in the heart center. In local-use logs, the low-grade nature and unexacting waste tolerances of the products make requirements unexacting. In these logs the main consideration is that of excessive size of abnormalities or excessive amounts of scalable defects which arbitrarily disqualify the log for the class.

Within a given type of log, there are a number of general circumstances under which abnormalities may be disregarded as defects. Certain kinds which may have been included in the logs through operational error can be disregarded under certain conditions.<sup>3</sup>

Other abnormalities are often superficial. That is, they extend into the log for a distance less than one-fifth of the log diameter (2 inches on a 10-inch log) and hence do not enter the milling frustum or the included timber deeply. In such cases, they can be disregarded.

Since the conditions which make an abnormality a log defect in one case and not in another vary so much, there can be no general classification covering all abnormalities and all log types. Therefore, the following discussions of individual log abnormalities cover not only the description of the abnormalities but also their significance in relation to use-classes or other variables. No mention is made of the *degree* of degradation caused by log and wood abnormalities classed as defects. Within a given class of log, some defects are more damaging than others, but the effect may be conditioned by such other factors as log diameter or straightness. This subject is discussed later under the heading "Classification and Evaluation of Log Abnormalities."

<sup>3</sup> In judging logs in standing timber, the appraiser has a certain latitude as far as inclusion of log defects is concerned. He can assume that cutters will use reasonable judgment and eliminate a cull section, bad crook, or fork. When the log has been cut, however, it must be judged "as is." The authors have followed this principle in their judgments on defects, except in the case of features which are obviously included through operational error and the actual elimination of which is still practical. It may be argued that any defect which can be removed from the log or product by relatively simple operation, without chopping up the product unduly, could be disregarded, provided a loss in scale were taken. Although there is merit to this argument, the nature of log defects can not be adequately discussed unless it is considered that, with a few exceptions, they cannot actually be removed from the log.

## LOG SURFACE ABNORMALITIES

Log surface abnormalities are unquestionably the more important of the two classes of log defects. There is a better chance of observing indicators of wood blemishes on the surface than of seeing the blemishes themselves on the log end, and distribution and frequency of product defects can also be judged best from the surface indicators. All of the following discussions of surface indicators of log defects are complete and inclusive; a covered blemish associated with a log defect is not discussed again as an end defect.

### *Adventitious Bud Clusters*

*Definition.*—Adventitious bud clusters (fig. 4) are abnormal groups of buds found at points on the stem unrelated to the crown. They originate in the cam-



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FIGURE 4.—Adventitious bud cluster.

bium layer of the tree bole and may be formed at any time throughout the life of the tree.

*Occurrence.*—They are found most frequently on all species of elms, oaks, and maples.

*Significance.*—Underlying the adventitious bud clusters are very small knots or small bark pockets in the wood. Sometimes the blemishes arising from a particular cluster that is visible on the surface may

not extend very far into the wood. However, a succession of others of similar origin generally appears farther in the log. Wood blemishes caused by adventitious buds stop clear cuttings and are log defects in *factory logs*. However, the knots and bark pockets that the bud clusters indicate do not constitute defects in tie and timber logs. Adventitious bud clusters can also be disregarded in *local-use logs*.

### *Bulge*

*Definition.*—A bulge is a general enlargement of the stem of a tree or log, in the nature of a “barreling” effect, often without an obvious cause such as knot or callus formation. It may be near a wound, rotten knot, knothole, or other point of entry for rot. It generally indicates a cull section with the extent of the rot shown by the extreme limits of the deformation. There are two types of bulges, butt bulge and stem bulge (figs. 5 and 6).



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FIGURE 5.—Butt bulge.



FIGURE 6.—Stem bulge.

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Butt bulge is nearly always accompanied by hollow butt. Rot generally extends beyond the hollow, and the upper tapered-off limit of the bulge usually indicates the approximate upper limit of serious rot. Butt bulge has no special relation to species, although it is most frequently of conspicuous development in the oaks. In species like sweetgum, elms, and ashes, even considerable butt rot may not cause a clearly defined butt bulge. In these species, the bark over even a slight bulge often becomes smoother and darker and scales off faster than in a sound stem. This is especially true in sweetgum.

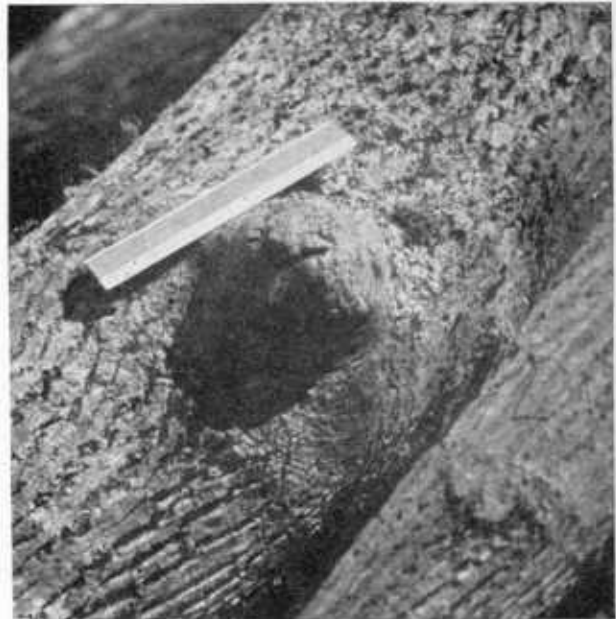
Stem bulge is not as common as butt bulge, but it may be found in any species.

**Significance.**—As indicated above, bulges are evidences of internal cull and under good operating practice are not included in logs. If all or a portion of a bulge is included in a log and the part involved can be cut off, the bulge need not be considered a defect. Butt bulges can generally be so treated. If a stem bulge occurs in the middle of a log, where it cannot be cut out, then the area involved must be considered as a cull section and, therefore, in *factory lumber logs* a

defect. A stem bulge will disqualify a log otherwise suited for *ties* or *timbers*. In *local-use logs*, the bulges can be overlooked, provided the accompanying rot does not exceed the cull limits set for the class. The identification and evaluation of bulges is most important in dealing with standing timber. In logs, a bulge, unless included in its entirety, may show as an abnormal end taper and cull may be the controlling factor.

### Bumps

**Definition.**—A bump is a protuberance on the log which is covered with wood and bark (fig. 7). It may be abrupt or it may be a smooth undulation which



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FIGURE 7.—Bump.

gradually tapers back in all directions to the normal contour of the log. A minimum bump is arbitrarily defined as a swell on the surface with a taper steeper than 1 to 6 (i. e., it is a bump if the distance from the center to the edge is less than six times the height from the normal contour to the top). If it has a taper flatter than 1 to 6, it is classed as a surface rise (p. 22). Low bumps are those with a taper of 1 to 6 to 1 to 3; high bumps have a taper sharper than 1 to 3.

**Occurrence.**—Bumps are likely to occur on any species. Low bumps are particularly noticeable in hard and soft maple, tupelo, soft elm, birch, and the ashes, magnolias, and white oaks. High bumps are conspicuously frequent in cedar elm.

*Significance.*—About nine-tenths of all bumps indicate knots, sound or rotten, projecting limb stubs, a cluster of adventitious buds, or an excessive folding or ingrowing of the bark over a scar.

*In factory logs*, low bumps can be disregarded in hard and soft maple, tupelo, soft elm, birch, and the ashes, magnolias, and the better white oaks; but high bumps in these species are defects. In other species all bumps are defects, for even low ones cover blemishes which are usually in the outer rim of wood where they will limit clear cuttings.

*In tie and timber logs*, the effect will depend upon the size of the underlying blemish. If the diameter of a high bump is less than one-third of the diameter of the log at the point where the bump occurs, or if the diameter of the feature underlying the bump is estimated to be less than one-fourth of the width of a face of the largest included timber (judged from the small end of the log), then the abnormality can be disregarded as a defect. If the underlying feature is larger, it is a defect. In the case of a low bump, it is difficult to estimate the size of the underlying blemish. However, the blemish will generally be so large that a low bump must be considered a log defect in overcup, chestnut, pin, scarlet, black oak, and the water oaks, and in cedar cln. In other species, low bumps can be disregarded as defects in tie and timber logs.

*In local-use logs*, bumps of both kinds are log defects if their diameter exceeds one-half the diameter of the log at point of occurrence; otherwise they can be disregarded.

### Burls

*Definition.*—A burl is a sound, hard, woody protuberance on the bole, more or less rounded or horizontally ridged in form, with no protruding limbs, twigs, stubs, or indications thereof (fig. 8). It is sometimes related to aborted adventitious buds.

*Occurrence.*—Burls are uncommon, but are most often found on hard maple, cow oak, walnut, the magnolias, and occasionally yellow-poplar and northern red oak.

*Significance.*—A true burl is a surface indication that the grain in the wood is distorted into a wavy, curly, or bird's-eye effect. Other similar apparently sound abnormalities, popularly classed as burls, may contain considerable amounts of bark, rot, and even insect channels. In factory logs, the true burl, if it can be identified, technically is not a defect. However, the difficulty of identifying true burls requires that all features ordinarily considered as burls be



FIGURE 8.—Burl.

classed as defects in *factory lumber logs*. Since burls would unquestionably weaken a *tie or timber*, they must be considered defects in these logs. In *local-use logs*, however, they can be disregarded unless their diameter at the point of occurrence is over one-half the diameter of the log at that point.

### Butt Scar

*Definition.*—A butt scar is a generally triangular or wigwain-shaped opening at the base of the bole, from a few inches to several feet high (fig. 9). It may show weathered or stained or doty sapwood, rotten heartwood, or may be the opening into a rotten hollow butt. When associated with advanced stages of rot or hollow, it may be accompanied by a butt bulge (p. 6). It is caused by anything that "skins" the base of the tree. Fire is the commonest cause; others are logging and cattle. Pin- and shot-worm damage (pp. 27 and 28), which are log defects in factory logs, are closely associated with butt scars.

*Occurrence.*—Butt scars may be found on all species.

*Significance.*—Since butt scars generally are associated with severe rot, the log is usually started above the butt swell. However, sometimes a butt scar of recent origin with a limited amount of rotten or stained

wood is left on the log. In *factory logs*, the area involved is a defect, even though cull deduction is made for it. In *tie and timber logs*, a butt scar may be disregarded if it and the associated rotten wood are super-



FIGURE 9.—Butt scar.

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ficial and do not enter the included tie or timber. In standing trees, butt scar and associated rot may be disregarded if the logs can be cut so as to meet the minimum requirements of the log class. Otherwise butt scar is a defect. Butt scar is not a defect in *local-use logs*.

### Butt Swell

**Definition.**—A butt swell is an enlargement of the bottom end of the tree trunk, over and beyond the normal stump flare generally found in all species (fig. 10). It is a normal development, apparently related to wetness of site, but not to injuries. Trees with butt swell are sometimes called “churn-butted” or “bottle-butted.”

In standing timber, butt swell may be confused with butt bulge. Butt swell is related to site and confined to species listed below. Butt bulge, which is due to injury and internal rot, is found in other species, especially oak, and is distributed more widely. Sounding

the butt with an ax or carefully searching for wounds or butt scars will aid in identification. In the log there will be no question, for the wood in the butt swell will be sound, whereas it is likely to be very rotten in a butt bulge.

**Occurrence.**—Butt swell is found in tupelo, swamp blackgum, red maple, and green ash. Within the species, the degree of butt swell varies according to depth, duration, and seasonal occurrence of water.

**Significance.**—Butt swell is not a reflection of and is not related to recognized imperfections in the underlying wood. It does not reduce lumber grade, and therefore is not a log defect in *factory logs*. However, the wood in the swell is often soft enough to limit the use to which the lumber can be put. For instance, green ash lumber cut from swelled butts, although graded by standard rules, is classed in the trade as “cabinet ash,” and does not command the high price obtainable for “firm or better” taken from further up



FIGURE 10.—Butt swell.

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the same tree. For tie and timber and local-use logs, swelled butts in the harder species are likewise not a factor. In tupelo, the swelled section may be so soft as to be worthless for any purpose. Then the log is started above the butt swell, which therefore can be disregarded.

### Canker

**Definition.**—A canker is a definite, relatively localized necrotic lesion, primarily of bark and cambium (fig. 11). It is sometimes associated with a conk and



F-455591

FIGURE 11.—Canker.

usually is an entrance for decay. In advanced stages it is evidence of serious heart rot, generally extending downward.

**Occurrence.**—It is commonest on the red and water oaks, hickories, and ashes.

**Significance.**—In good operating practice, a canker normally is not included in the log. Should it be included, it is a definite defect in a *factory log*. It is a defect which will disqualify a log otherwise suitable for *ties or timbers*. An included canker can in itself be disregarded in a *local-use log*.

### Conk

**Definition.**—A conk is usually a fibrous but sometimes a fleshy excrescence of definite form and struc-

ture on the bole (fig. 12). It is the fruiting body of a rot-producing fungus contained in the tree.

**Occurrence.**—Conks may occur on all species.

**Significance.**—A conk usually is accompanied by rot close to or in excess of the amount allowed in a merchantable log of any type. However, if the log will qualify as a *factory log*, the conk, together with the associated rotten area, becomes a defect. It will limit cuttings outside of the heart center even though cull deduction is made. In a log otherwise suitable for *ties or timbers*, conk is a definite defect, for it is evidence of rot in the log interior which will disqualify the log. In a *local-use log* the conk can be disregarded as a defect, provided the rot with which it is associated does not exceed the cull limit for the log class.



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FIGURE 12.—Conk.

### Flanges

**Definition.**—Flanges are buttress- or wing-like forms at the base of the tree (fig. 13). They are exaggerated projections or convolutions of the normal stump flare, and usually extend up the bole beyond normal stump height, sometimes for 4 or 5 feet from the ground. They appear to be related to wetness and softness of ground.

**Occurrence.**—Most common in elms, water oaks, and soft maple.

**Significance.**—The wood in flanges is, by definition, superficial and thus outside the milling frustum or



F-455580

FIGURE 13.—Flanges.

included timber. Furthermore flanges do not reflect and are not related to blemishes or imperfections in the underlying wood. Therefore, in all types of logs, flanges are not log defects.

### Flutes

**Definition.**—Flutes are folds or convolutions of the surface of the trunk running up and down and generally confined to the base (fig. 14), but occasionally extending even up into the second log. They often include ingrown bark. They appear to be of normal origin, related to softness of site, much as flanges are; in fact, they are often confused with flanges.

**Occurrence.**—They are found most commonly in soft and cedar elm, soft maple, and occasionally in water oaks, pecan, and magnolias. The most exaggerated flutes are found in cedar elm.

**Significance.**—Flutes usually do not extend deeply into the log at the small end. When they do not, they may be disregarded in all classes of logs.

Flutes are defects when they extend into factory logs for a depth exceeding one-fifth of the log diameter, or into the included timber in tie and timber logs. They may be disregarded in local-use logs.



F-455592

FIGURE 14.—Flutes.

### Fork

**Definition.**—A fork is a crotch between double tops (fig. 15). It is sometimes included when logs are bucked to arbitrary lengths.

**Significance.**—A hidden effect of a fork is double pith and, generally, a bark pocket. In the fork portion, grade outturn and volume yield are both lowered

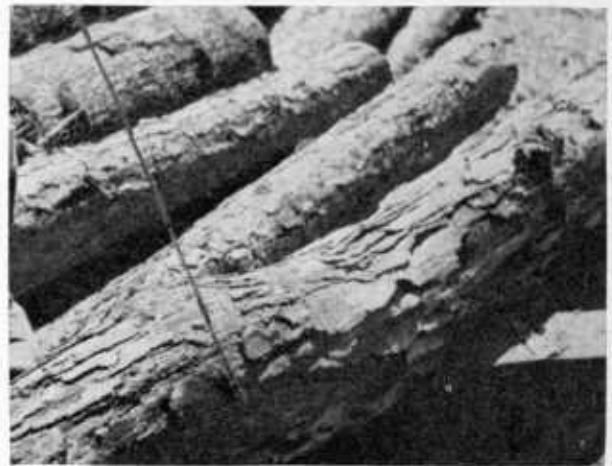
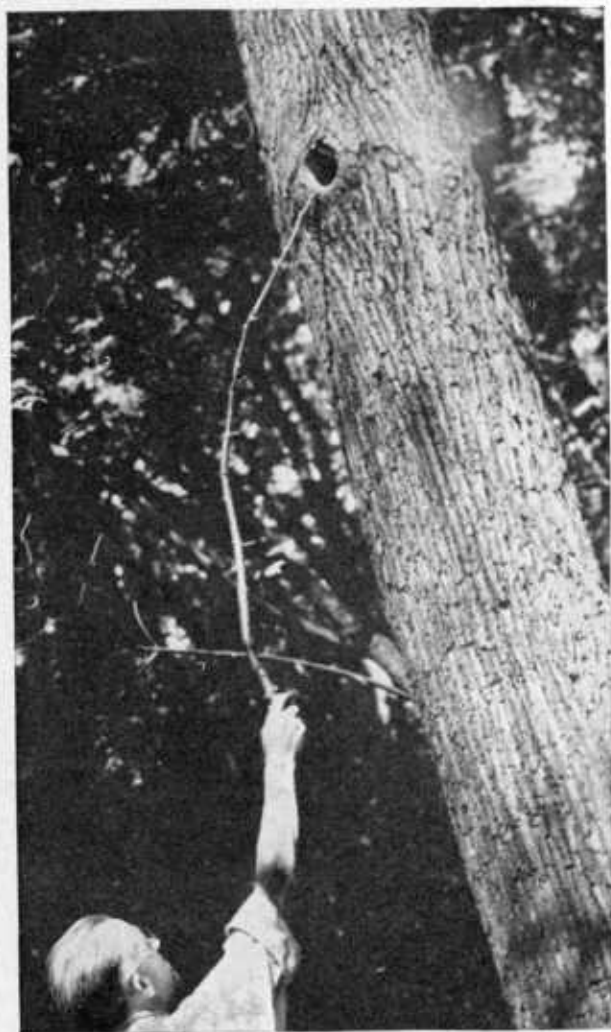


FIGURE 15.—Fork.

significantly. Including a fork on a log is an operational error. *In tie and timber logs*, the section should be culled back to a point behind the separation. *In factory logs*, the seam and any enclosed bark should be scaled out following the standard practice for deducting for interior defect; but if the portion scaled out is so large that it precludes cuttings, then the fork is a defect. In standing timber, however, a fork is not a log defect so long as logs can be cut which fulfill the minimum requirements for the log type. Forks can be disregarded in *local-use logs*.

### Large Holes

**Definition.**—Large holes are unoccluded openings over one-half inch in diameter (fig. 16). Among their



F-455595

FIGURE 16.—Large hole.

causes are rotten knots, birds excavating infected spots, and logging operations.

**Occurrence.**—Large holes may be found in all species.

**Significance.**—*In factory logs*, all large holes are defects. *In tie and timber logs*, they are defects if their size is over one-third the diameter of the log at the point of occurrence, or if, regardless of size, they extend more than 5 inches into the log. If they are smaller or shallower than this, they may be disregarded, provided they are surrounded by sound wood. Otherwise, they are defects. *In local-use logs*, large holes may be disregarded unless their size is over one-half the diameter of the log at the point where the hole occurs.

### Medium Holes

**Definition.**—Medium holes are unoccluded openings, three-sixteenths to one-half inch in diameter, through the bark into the wood. They include emergence holes of grubs, tap and increment borer holes, and openings made by sapsuckers and carpenter ants.

Origin of the holes can be determined with some readiness. Grub holes are clean-cut and unstained, except in black oak logs where the tunnels are stained black; they are usually more than 1 inch deep, are irregularly spaced, and ramify through the wood. Increment borer holes are of the same general character but do not ramify. Sapsucker holes are usually found in rows or bands, although occasionally the entire log may be freckled with them. The individual holes usually extend only slightly, if at all, into the wood. Ant holes are irregularly spaced, but are not clear-cut. They are generally accompanied by frass and often by a dark-colored exudation. They may or may not be superficial, depending upon whether the insects have been working on the cambium through a crack in the bark or in a borer channel.

**Occurrence.**—Medium holes are found on trees of any species. Sapsucker work, which results in the familiar bird peck, is most often found in the hickories, elms, and sweetgum, but occasionally in the oaks and maples, and in birch. Insect work is most prevalent in the oaks. Tap holes will be found only in sugar maple butt logs.

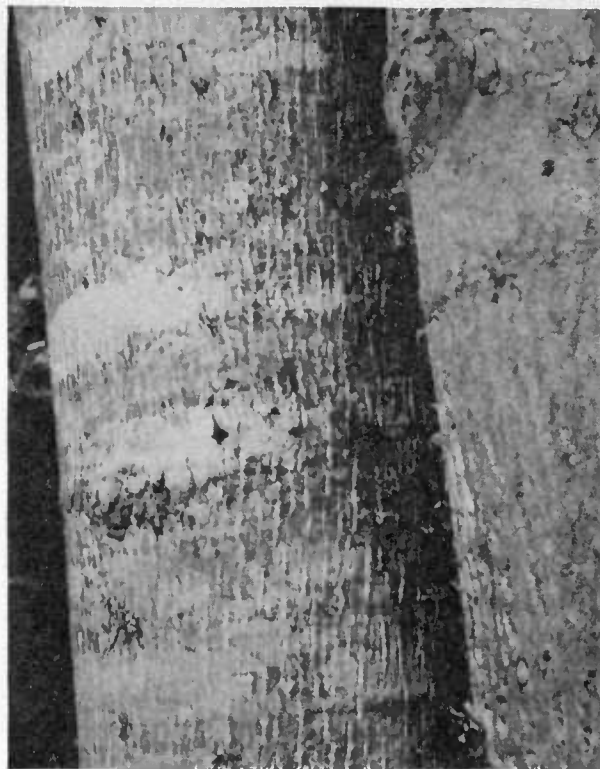
**Significance.**—Medium holes can be disregarded in *tie and timber* and *local-use logs*. *In factory logs*, they are extremely important defects, but significance may vary with origin, age, or concentration.

Grub holes (fig. 17), increment borer holes, and tap holes are definitely defects in *factory logs*, for the hole



F-455639

FIGURE 17.—Grub hole.



F-455951

FIGURE 18.—Light bird peck.

or channel in the lumber stops cuttings. Both increment borer and tap holes are generally accompanied by severe stain. With tap holes, there often is enough rot so that an entire section must be culled. In addition, tap holes so often have forgotten dangerous metal spouts that butts are usually "jumped" when a metal detector is not used at the mill.

Significance of sapsucker holes depends primarily upon age and concentration. Fresh or light bird peck (fig. 18) may be disregarded in *all types of logs*. (Test for freshness is lack of associated similar holes which are occluded by callus tissue; measure of lightness is four pecks per square foot.) There are two cautions in connection with light and fresh bird peck. One is that trees so damaged have generally been subject to previous and often repeated attack, and will have occluded holes (overgrowths, page 16). When such a combination occurs, it is a defect in factory logs. A second caution relates to the hickories, even light bird peck often results in circular columns of purple stain running for considerable distances up and down the tree. This stain is not a defect on lumber but does constitute a degrading influence on handle stock.

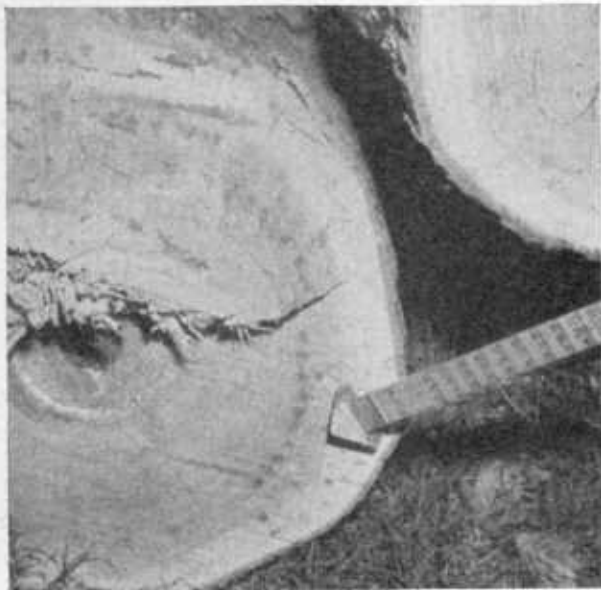
Heavy bird peck (fig. 19), on the other hand, is generally older and usually is accompanied by overgrowths.



F-455593

FIGURE 19.—Heavy bird peck.

The effects extend into the wood in the form of bark flecks or callus pockets. Heavy bird peck is a defect in *factory logs* (fig. 20), but not in *tie and timber* and *local-use logs*.



F-455583

FIGURE 20.—End view of hickory log showing stain caused by bird peck.

Ant holes, if fresh, may be disregarded in all three classes of logs. Fresh holes show no frass, exudations, or occlusions. Ant holes that are not fresh are defects in *factory logs* but not in *tie and timber* and *local-use logs*.

### Small Holes

**Definition.**—Small holes are unoccluded openings less than three-sixteenths inch in diameter leading into the wood (fig. 21). They are generally associated with rot or wounds and are confined to the immediate vicinity thereof. They are made by several genera of ambrosia and other beetles.

**Occurrence.**—There appears to be no significant relation to species. Ambrosia beetles seem to prefer the softer and sappier species such as sweetgum, but are also found in the harder species. Shot worms are most prevalent in red oaks, ashes, and sweetgum and appear to favor heartwood.

**Significance.**—Small holes on the surface are generally accompanied by other features which may or may not be log defects. In *factory logs*, the usual effect of small holes is to extend the area of other defects, such as wounds. The area in which the insects

work is definitely a defect, however. Small holes may be disregarded in *tie and timber logs* and in *local-use logs*.

### Knots

**Definition.**—Knots are cut or broken-off limbs or sprout branches, green or dead, protruding, flush, or depressed, but with exposed sound or rotten wood (figs. 22 and 23). If the exposed wood is sound, the knot is a "sound" knot; if rotten, it is an "unsound" knot.

**Occurrence.**—Knots are common to all species, but the frequency depends upon the habit of the tree. Cottonwood, tupelo, yellow-poplar, and the ashes and basswoods, for example, usually are conspicuously free from knots. Pin oak, scarlet oak, and (on poor sites) black oak are conspicuously knotty.

**Significance.**—A knot on the surface of the log or tree represents a knot in the underlying wood.

In factory lumber, the degrading effects arise from the distribution, which determines the yield of clear



F-455594

FIGURE 21.—Small holes.

cuttings, rather than from size, character, and condition of the individual knots. Obviously, large knots will limit cuttings more than small knots. But a knot in lumber, no matter how small, will limit a cutting. Thus, any knot is a defect in *factory logs*. Even surface knots, arising from adventitious or sprout limbs, cannot be discounted. While a particular knot of this origin may taper out at a shallow depth, it generally indicates successive layers of such knots for an indefinite depth into the wood.

In *tie and timber logs*, the degrading effect of a knot depends upon an entirely different set of circumstances. If the knot is larger than one-fourth of the face of the largest included timber (measured on the small end of the log), or if it is very rotten, it is definitely a defect because it will affect the strength of the piece. Guides to the breaking point between the two conditions are as follows: A sound knot is a defect in a tie and timber log if the diameter of the knot collar at the point of occurrence is greater than one-third the diameter of the log at that point. Knots smaller than this can be disregarded as defects if they do not occur in whorls equaling the effect of the larger knot, and provided they are sound. If they are in whorls, then the combined effect must be considered and a whorl of small knots the sum of whose collars exceeds the limit for the single large knot is a log defect. Unsound knots are judged by the same rule as sound knots, so far as size is concerned, but the rot cannot extend more than



FIGURE 22.—Sound knot.

3 inches into the included timber. In practice, this means that an unsound knot of acceptable size is a defect if the rot extends into the log for a distance exceeding one-fifth of the log diameter.

In *local-use logs*, the only limitation on knots is that they do not extend clear across individual pieces of



FIGURE 23.—Unsound knot.

lumber. A good rule is that a knot is a defect if the collar diameter exceeds one-half the diameter of the log at point of occurrence or if the aggregate diameter of a whorl of smaller knots is of equal effect. Other knots, even if unsound, may be disregarded.

### Limbs

**Definition.**—A limb is a branch or subdivision of the stem or an outgrowth from the stem (fig. 24). It may be part of the original branching, starting at the pith of the main stem, or it may have started later from adventitious buds at varying distances from the pith.

**Occurrence.**—Limbiness varies with growth or development habit of each species. It also varies with conditions of growth (such as spacing and site) and age and size. Species generally most free from limbs are cottonwood, tupelo, yellow-poplar, and the ashes and basswoods. Oaks—particularly black oak on poor sites, scarlet oak, pin oak, and the water oaks—are very limby.

**Significance.**—Limbs, of course, will be reflected in generally sound knots in the sawed product. These, regardless of size, condition, and character, degrade factory lumber; hence, limbs are log defects in *factory logs*. In *tie and timber logs* and in *local-use logs*, the same rules apply that relate to knots; namely, there is a size limitation. If the limbs are above the size limitation or if smaller and arranged in whorls, they are defects which may prevent a log otherwise qualified from being put in one of these two classes. Otherwise, they may be disregarded.



F-455593

FIGURE 24.—Limbs.

### *Overgrowths*

Many log surface abnormalities are features which constitute a break in the normal bark pattern of the tree. Knots resulting from broken branches, mechanical wounds (as from ax blaze or logging), and discrete holes such as those made by sapsuckers or ants on the outside or those made by the emergence of insects from the inside, are features of this nature. As the tree develops, such features are covered over by callus tissue and finally engulfed in the wood. Over larger items, as the years pass, the bark reforms and the existence of the feature in the wood is shown by a deformation of the general normal surface contour. A bump (p. 7) is an example of this.

Smaller items may be entirely "lost" when they are deeply buried, as far as any external evidence is concerned. However, for many years, until they become so deeply buried as to lose significance as product defects, most items leave on the surface of the tree or log either a definite structure of callus, or an identifiable break in the normal bark pattern. *Such features are classed as overgrowths.* They actually are phases of other log abnormalities described elsewhere. However, because many of them are inconspicuous and

easily overlooked and because they are the least generally understood of all the hardwood log surface abnormalities which may or may not be defects, they are considered together for emphasis.

A recently overgrown knot is an example of a very conspicuous and easy-to-recognize feature in this class. Less easily recognized are evidences of old ant and grub work. Such damage may be so hidden that the only superficial indication of its presence is a general appearance of the bark which to the trained eye signifies a need for close search for individual overgrowths. The importance of overgrowths in the evaluations of hardwood factory lumber logs in particular cannot be overemphasized. Appraisal on the basis of all other log defects would, in most situations, be fallacious if overgrowths were not consistently recognized and given full weight as defect indicators (fig. 25).

These overgrown abnormalities may be grouped into four relatively distinct classes, three based on origin, and a fourth in which origin is uncertain.

#### *Overgrowths Due to Knots and Bark Pockets*

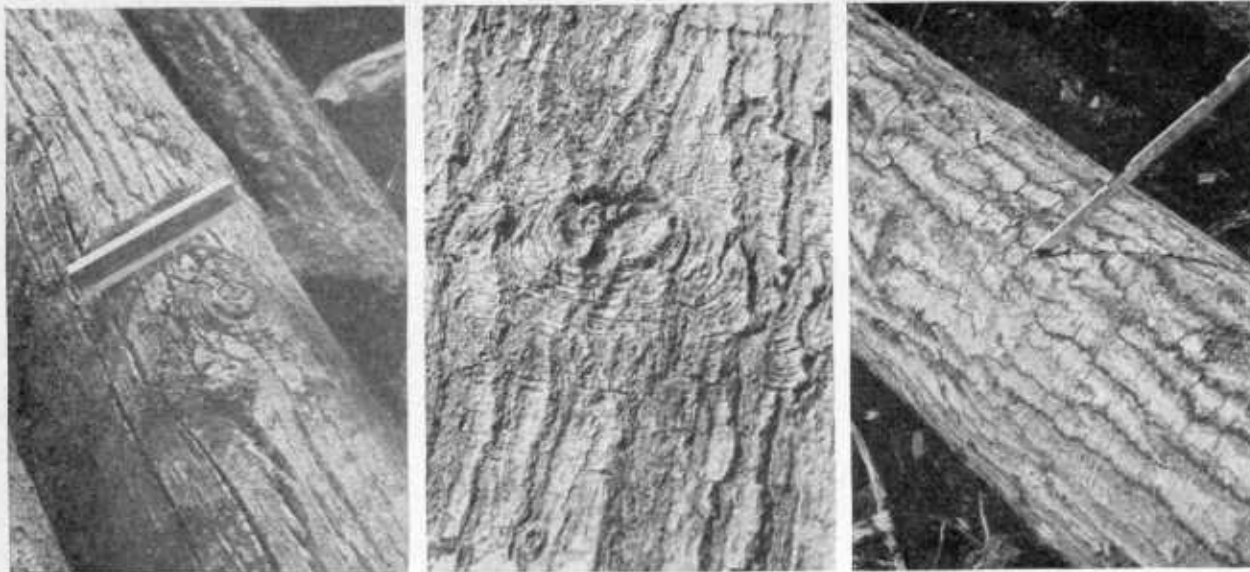
*Definition.*—The most obvious overgrowths are those indicating overgrown or buried knots and coarse bark pockets (fig. 26). Where single knots are involved, the overgrowth in the early stages of development takes the form of the underlying defect. The knot is covered over with callus tissue or there is a circular excrecence of callus tissue around the knot, but still a separation between this tissue and the normal bark. The knot is gradually engulfed as time goes on, but for many years definite swirls or lines form on the bark, making a characteristic pattern or roughly concentric circles.

These patterns, which are so definite that there can be no mistaking their cause, persist until the knot becomes so deeply buried that there are clear boards between it and the first saw line. Then the characteristic signs gradually disappear, and the deeply buried knot is evidenced by a bark distortion which may be merely a faint break in the normal bark pattern. When bark pockets or clusters of small knots (generally from sprout growth) are involved, a small rise or slight bump may be formed during the early stages of overgrowth. The bump or rise resembles that covering a large single knot. These small bumps sometimes run together to form a sort of rosette. The final stages are similar to those of the single knot, except that the bark overgrowth is apt to be wider and more irregular.



F-455564-75

FIGURE 25.—Overgrown features are of fundamental importance in judging the quality of hardwood timber. *A* and *B*, Overgrowth in water oak caused by small knot just recently buried. *C* and *D*, Overgrowth in blackgum due to deeply buried knot. *E* and *F*, Small adventitious limb on white elm leading to knots. *G* and *H*, Overgrown adventitious buds. *I* and *J*, Bird peek in forked-leaf white oak. *K* and *L*, Large ant-caused overgrowth in overcup oak.



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FIGURE 26.—Overgrowths caused by knots.

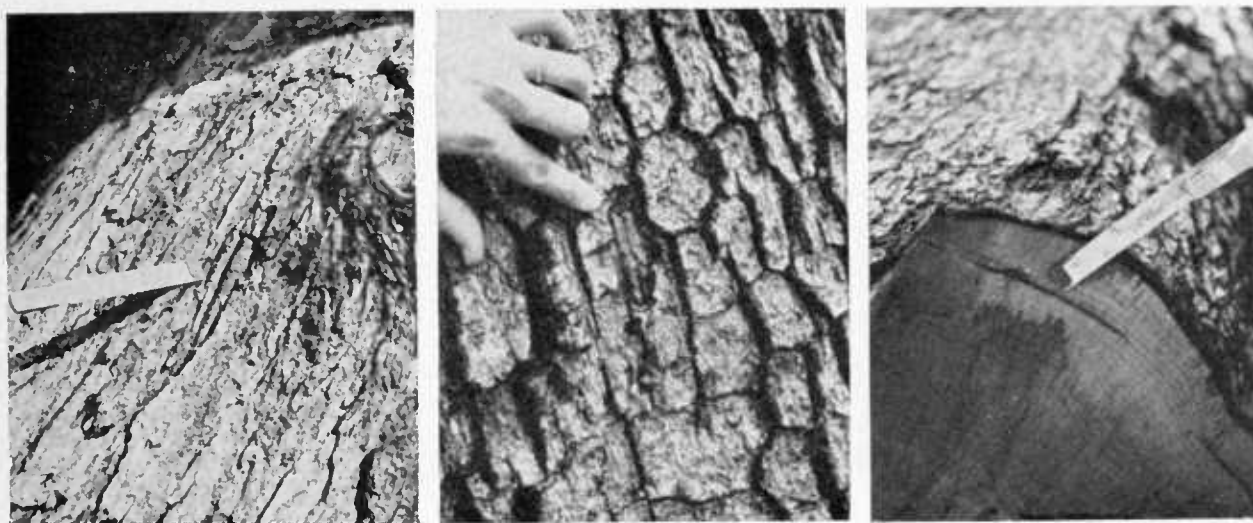
*Occurrence.*—There is no relation between such overgrown knots and species except that some species are limber than others. This class of defect is often overlooked in well-stocked stands of rapidly developing, well-cleaned second growth. Recognizing overgrowths in such stands is particularly important because, although general appearance may be one of clearness of bole, the underlying knot is just beneath the slab.

*Significance.*—Each overgrown knot or bark pocket indicates an imperfection in the underlying wood. *In factory logs*, each overgrowth is a log defect. *In tie*

*and timber logs*, the overgrowths can be disregarded except when they are of abnormally large size, or, if small, when whorled (p. 15). Overgrowths of this class can be disregarded *in local-use logs*.

#### *Overgrowths Due to Insect Attack*

*Definition.*—Common and extremely important bark distortions are the occluded holes caused by the work of such insects as wood borers and ants (fig. 27). Borer work results in a sharp pucker which consists of a pitted core, generally not over  $\frac{1}{4}$  inch in diameter, surrounded by callus tissue and distorted bark over an



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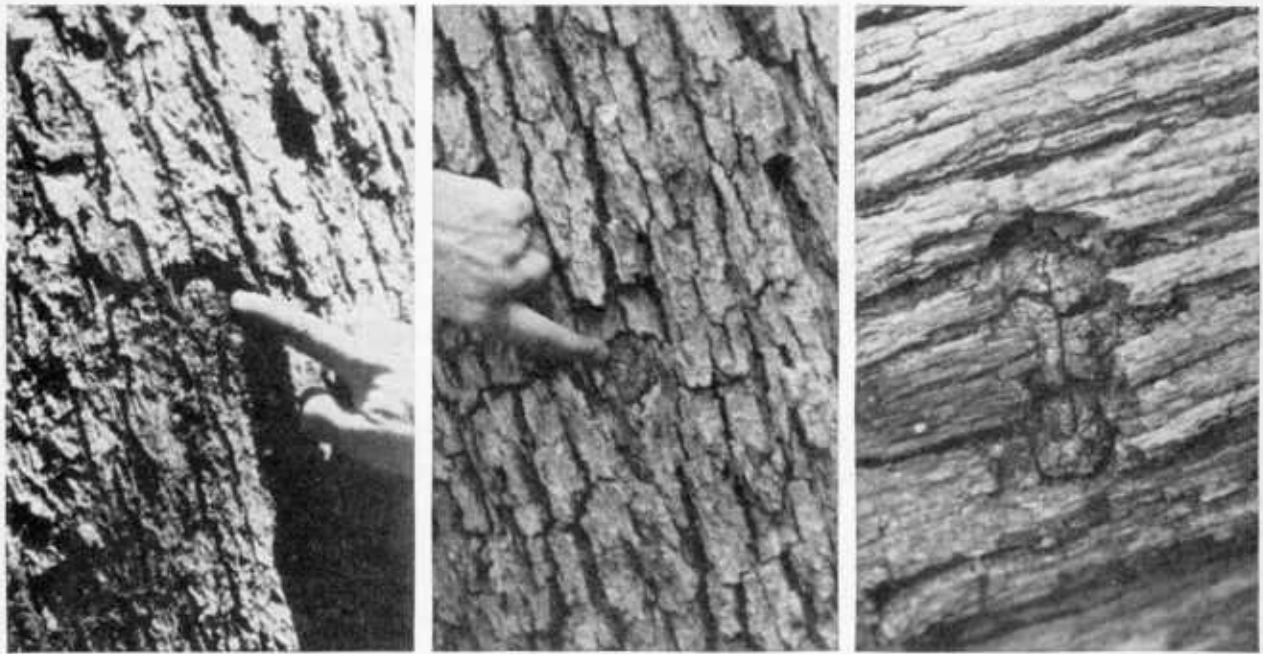
FIGURE 27.—Overgrowths caused by ants.

area  $\frac{3}{4}$  to 2 inches in diameter. Ants cause a vertical slit from  $\frac{3}{4}$  to 3 inches long with callus area on both sides. The total maximum affected area is typically about  $2\frac{1}{2}$  inches wide and 4 inches long. The most extreme development of this latter type often looks like a small, healed blaze wound.

Extremely severe borer work may cause a round "plaster" of callus tissue as much as 3 inches wide (fig. 28). In late stages, projecting scales of normal bark from surrounding areas may hide these distur-

Within the other hickories, occurrence is likely to be most important on poor, dry sites, whether lowland or upland.

In the oaks, three groupings can be made. In the first group are those usually practically free from this type of overgrowth. They include cow, Delta post, northern red, Shumard, swamp white, forked-leaf white, and cherrybark oak. (Damage to cherrybark oak is pretty well confined to ant work, which is occasionally serious in overmature trees or on poor sites.)



F-455631-33

FIGURE 28.—Overgrowths caused by grubs.

tions. These concealing bark scales, particularly in mature trees, may contain holes  $\frac{1}{8}$  to  $\frac{1}{4}$  inch in diameter, or exhibit numerous transverse breaks, cracks, or ridges which are indications that overgrowths are present (fig. 50, p. 32).

*Occurrence.*—This class of overgrowth is definitely related to species and within species to site and past vicissitudes. Although widespread over the entire East, it is most prevalent in the South. Especially in the valleys of the Mississippi and its major tributaries, occurrence is related closely to sites. Occurrence is affected not only by the sharp differences between the alluvial and upland situations, but also by the widely varying growth conditions in the lowlands.

The oaks and some of the hickories are the species most susceptible to attack. Of the hickories, sweet pecan is an exception and is almost entirely free.

In the second group are those generally infested—laurel, obtusa, scarlet, overcup, turkey, chinquapin, and chestnut oak. In local areas with extremely good site or growing conditions, this second group may be relatively free from insect-caused overgrowths. But when found on poor upland and mountain sites or on areas with a bad fire history, the last four species in particular are likely to be badly damaged.

The third group may be divided into two subgroups. The first subgroup includes those oaks which are generally found both on better drained lowlands (principally terraces and second bottoms) and on upland sites. They include forked-leaf white (when found on these sites), black, southern red, post, and shingle oak. Insect-caused overgrowths are most likely to be found in timber from dry, poor sites, such as exposed high slopes, ridge tops, and most Coastal Plain pine sites. On normal good hardwood sites, insect damage is

usually slight or absent in these species. White oak is especially free.

Occurrence of these overgrowths in the second subgroup, the typical flood-plain species (Nuttall, burr, willow, pin, and water oak), usually varies more widely than in the upland species. Here the timber is likely to be very bad when the trees are growing in hardpan flats on terraces, in backwater areas where there is prolonged inundation and tight clay soils, and on dry upland sites away from alluvial soils. Site variations in general and soil variation in particular, together with degree of freedom from fire injury, may drastically reduce or increase occurrence in these species. These species are likely to be relatively free from this defect on good flood-plain sites, but *only* on such sites. In this third group are many other hardwood species in which insect-caused overgrowths may be found, particularly in trees on unfavorable sites. However, there are not the definite relationships nor the plain indicators found in the oaks, except that green ash in poor, deep swamp sites may show serious infestation over wide areas. Insect-caused overgrowths are also likely to be important in extra large, overmature, and decadent sycamore.

**Significance.**—Grub- or borer-caused overgrowths mean channels in the wood and generally bark pockets at the point of emergence. The holes indicated by this type of overgrowth are rarely under one-fourth inch in diameter and are often associated with rot and stain. A particularly bad feature, which makes it hard to isolate the effect of any one occlusion, is that the borer channels may run in any direction or pitch into the log. In factory lumber, each channel or hole in a board is a defect and *in factory logs*, therefore, each overgrowth is a defect. *In tie and timber logs*, however, unless the holes are very numerous (in which case there are usually accompanying defects of other nature, such as loose heart, shake, and rot), the holes and channels are not considered in grading the product. These overgrowths can also be disregarded *in local-use logs*.

Ant-caused overgrowths, on the other hand, indicate bark pockets which degrade factory lumber. The uncertain feature is the plane in which the imperfection lies. Although the particular bark pocket indicated by the overgrowth may affect only one or two boards (the result of cambium excavation), the presence of such abnormalities at all indicates the strong probability of additional similar lumber defects in different planes. Ant-caused overgrowths, therefore, are log defects *in factory logs* and may be disregarded *in tie and timber logs* and *local-use logs*. It should be

noted, however, that heavy ant work is commonly associated with check, shake, and dote. The combination often makes the log worthless for any purpose, just as in the case of grub damage.

#### *Overgrowths Due to Sapsucker Work*

**Definition.**—Overgrowths that come from the pecking of sapsuckers (not the usual woodpeckers) may be recognized by the conspicuous, horizontal row or belt pattern of occluded holes about one-fourth inch in diameter (fig. 29). Occasionally the entire log is freckled with such bird peck. Where the holes are continuous, a horizontal crack often forms.

**Occurrence.**—Species most susceptible to damage by sapsuckers are hickories, elms, sweetgum, and yellow-poplar. The oaks, maples, and birches are occasionally damaged moderately.

**Significance.**—Overgrowths of this class indicate imperfections in the wood consisting of small holes or groups of holes filled with callus tissue. One attack would cause only imperfections in one plane and would thus affect only a few boards in factory logs. However, most trees exhibiting such features have been attacked repeatedly over a number of years. The various degrees of occlusion and occurrence of horizontal cracks indicate how long ago the attacks occurred.



F-455599

FIGURE 29.—Overgrowths caused by sapsucker work.

The variability of damage makes it difficult to predict exactly the extent. However, except for very large butt logs, it is safe to assume that material damage extends far into the tree and affects a large portion of the volume. Thus these overgrowths must be considered as log defects *in factory logs*. Usually the damage does not weaken large pieces of wood, and, therefore, this type of overgrowth can be disregarded *in tie and timber logs and local-use logs*.

### Bark Distortions

**Definition.**—Bark distortions are breaks or alterations in the normal pattern of the bark (fig. 30). They exhibit no characteristic formation which will enable the cause to be established definitely from bark ap-



F-455637-38

FIGURE 30.—Bark distortions.

pearance alone. They are the result of the burying of any of the log defects already discussed. They may cover insect damage, wounds, bird peck, or, most commonly, knots.

**Occurrence.**—The relationship (as a defect) to species is that of the original cause. A smooth-bark tree, such as beech, carries the evidence of these deeply buried defects on the bole much more clearly than does a rough-bark tree like soft elm. Bark distortions are quite prominent on young sweetgum, yellow-poplar, cottonwood, and second-growth red and water oaks.

**Significance.**—Bark distortions reveal the presence of deeply buried blemishes. It is important to direct especial attention to them because they are difficult to see in their later stages, and consequently they are

easily overlooked by untrained eyes. They can be disregarded as defects *in tie and timber and local-use logs*.

Special studies by the Forest Products Laboratory show that they must be regarded as defects *in small factory logs* under 15 inches in diameter. Larger logs are another matter. In about half of the logs over 15 inches in diameter, the underlying defects were buried so deep that much clear wood could be obtained between the defect and the first saw line. In the other logs, the wood blemishes were in an immediately degrading position. The importance varied also with species. It was greatest in beech, for example, and least in hard maple. Altogether, the degrading effect of bark distortions is so variable *in large factory logs* that they can be disregarded.

### Seams

**Definition.**—Seams are longitudinal radial separations of the fibers in log or tree, either open or overgrown with callus tissue (fig. 31). If the seam is



F-455600

FIGURE 31.—Seam.

overgrown, bark is often encased. Seams are generally caused by wind, lightning, or frost. They are likely to be found in trees with cross or spiral grain, or which are buttressed or leaning, or have internal stresses from other special causes.

*Occurrence.*—Seams may be found in any species, but are common in the oaks, ashes, and maples, and in birch and honey locust.

*Significance.*—The significance of seams depends upon their depth. Often a seam is associated with rot, and consideration must be given not only to the seam but to the extent of the rot. *In factory logs*, if a seam together with any associated rot extends into the log for less than one-fifth of the log diameter, it can be disregarded as a defect. If it goes deeper, even though an area is culled out to allow for loss of lumber, it is still a defect in that it stops cuttings. *In tie and timber logs*, it can be disregarded if it does not enter the largest included timber, as measured on the small end of the log. If it is sound and enters the timber only slightly, say one-half inch, it will probably be permitted in the picce and therefore can be disregarded. However, if a sound or unsound seam enters the timber deeply, it must be classed as a log defect which will eliminate the log from or degrade it for this class of use. *In local-use logs*, most seams can be disregarded.

### Split

*Definition.*—A split is a longitudinal separation of fibers extending deeply into the milling frustum of a factory log or into the included tie or timber of a log designated for this use (fig. 32). A split is generally caused by operational accident or carelessness. Sometimes it results from the release of internal stresses when the tree is cut; such splits are usually called "checks."

*Occurrence.*—The pecans—especially bitter pecan—and the hickories are likely to split at any time because of release of internal stresses after cutting; cottonwood and willow often split badly at the peak of the growing season. Accidental splits can, of course, happen to any species, but most trouble is encountered in the pecans, the ashes, the hickories, and the red oak group.

*Significance.*—By definition, superficial minor splits can be disregarded. *In factory logs*, splits extending more than one-fifth the diameter into the log are defects even though the portion of the lumber ruined be scaled out. *In tie and timber logs*, splits on the end which do not extend lengthwise more than 5 inches beyond the trimming allowance can be disregarded.



F-455601

FIGURE 32.—Split.

Other splits must be considered as defects. *In local-use logs*, splits can be disregarded.

### Surface Rise

*Definition.*—A surface rise is a notable smooth undulation in the surface of the log or tree bole which gradually tapers back in all directions to the normal contour (fig. 33). Because of the nature of this ab-



F-455603

FIGURE 33.—Surface rise.

normality, there can be no minimum height specification other than the ability of the eye to notice it. One with the maximum height, however, has a taper of 1 in 6. When the taper is steeper, the abnormality is classed as a bump (p. 7). A surface rise is usually the effect of a small limb stub, a cluster of adventitious buds, or a deeply buried knot. Sometimes a rise reflects an earlier crook in the stem.

*Significance.*—Because the underlying lumber defects are so deeply buried that it is impractical to assess their degrading influence with consistent accuracy, surface rises can be disregarded as log defects in logs of all types. It is important to differentiate between a surface rise and a bump, because the latter is an important log defect. This is particularly hard to do when skidding has rubbed off some of the bark.

### Wounds

*Definition.*—Wounds are openings in the bark that expose sapwood and sometimes the heartwood (figs. 34 and 35). Wounds may be either *new* or *old*. A new wound is essentially a surface injury in which the exposed adjacent sapwood is apparently sound and around which there is not more than 1 year's callus formation. An old wound is an injury generally over



F-455605

FIGURE 35.—Old wound.

1 year old, still completely open or only partially healed over. It is generally characterized by unsound sapwood, local hollow, much callus tissue, insect damage, and often stained or actually rotten heartwood.

*Significance.*—In a new wound, deterioration is usually not serious, for any apparent insect damage or stain will be quite superficial. Therefore, under most conditions and for all types of logs, new wounds can be disregarded as log defects. However, in the southern lowlands and with such species as sweetgum, hickories, magnolias, and basswoods, early deterioration is apt to occur; if this enters the milling frustum, a new wound must be considered a log defect in *factory logs* but can be disregarded in others.

The seriousness of an old wound varies considerably with locality and with species. In some species in northern latitudes, exposed heartwood may completely heal over before serious injury occurs. As with other abnormalities associated with stain, rot, and insect damage, the affected area is a log defect in both *factory logs* and *tie and timber logs*, except in the rare cases where it is superficial. In the factory logs, even if cull deduction is made to cover the area involved in worthless wood, the area will stop a cutting. Old wounds can be disregarded in *local-use logs*.



F-455604

FIGURE 34.—New wound.

## LOG END ABNORMALITIES AND IMPERFECTIONS

The log abnormalities discussed heretofore have been those visible on the surface. As has been pointed out, these usually reflect imperfections in the wood, the cross sections of which may show in the end of the log. For example, on the ends can be seen the effects of bird peck, of grub work, of extreme rot, of knots, bark pockets, wounds, seams, flutes, and many other surface abnormalities. These and similar blemishes for which there are surface indications are not reconsidered in connection with so-called "end abnormalities," with one exception. This is grub channels, which are the cross or longitudinal sections of the channels of wood-boring insects which make definite and recognizable exit holes on the surface.

The log end may also reveal imperfections which normally have no surface indicators (log defects). These are the so-called hidden defects, and are those which demand local experience for their appraisal in standing timber.

Many of these end features are somewhat different from other product defects in that they are often admitted to a certain degree in the products and in that their degrading effect is often based on concentration rather than presence alone. Sometimes their effect is covered by special grades which admit the blemish without qualification, but which bring a reduced price. Their location, too, is important. Some which occur in the heart center only may be more or less disregarded in one type of log. In another type of log, the same imperfection in the same position will mean a complete culling.

Many of these features are difficult to judge because they are found on one end of the log only and the observer must use considerable judgment in determining how far into the log the blemish persists. Many are in the class of the scalable defects, and in judging their significance as a log defect, the relation to the particular product for which the log is best suited must be carefully considered.

### Dote

*Definition.*—Dote is an early stage of decay. The wood is discolored and weakened, but does not lose its structure (fig. 36).

*Occurrence.*—Dote can be present in all species, although in woods of low density, such as the magnolias, tupelos, or sweetgum, it passes rapidly into actual rot.

*Significance.*—In both scaling and manufacturing, dote is less consistently recognized and taken care of than is rot (p. 28). There are two generally recognized phases of dote—slight and advanced. The first



FIGURE 36.—Dote.

may have little effect on the strength of the wood, whereas the latter weakens it greatly. Advanced dote is generally scaled out, particularly if extensive or if found outside the heart center. In factory logs, dote within the heart center may be disregarded, whether scaled out or not, but dote outside the heart center is a defect whether scaled out or not. In tie and timber logs, dote is a defect, particularly when found in the heart center. Dote areas may be disregarded as log defects in local-use logs provided deduction for them does not exceed that allowed for the class by cull deduction.

### Double Pith

*Definition.*—When a tree bole forks and a log is cut just at the base of the fork, the end of the log will seem swollen and the top will have two separate pith centers, often separated by a bark pocket. This condition is called double pith (fig. 37).

*Significance.*—Double pith leads to cross grain in sawn products, together with a split or potential split from the bark pocket. The general approximate effect is that of two large knots. *In factory logs*, double pith is not a defect; however, the related seam and any enclosed bark should be treated as in the case of fork (p. 11). *In tie and timber logs*, double pith is a defect. In standing timber, double pith may be disregarded if the section including it can be cut out so as to leave logs of sufficient length to fulfill the minimum requirements of the log type. Double pith is not a defect *in local-use logs*.



F-455606

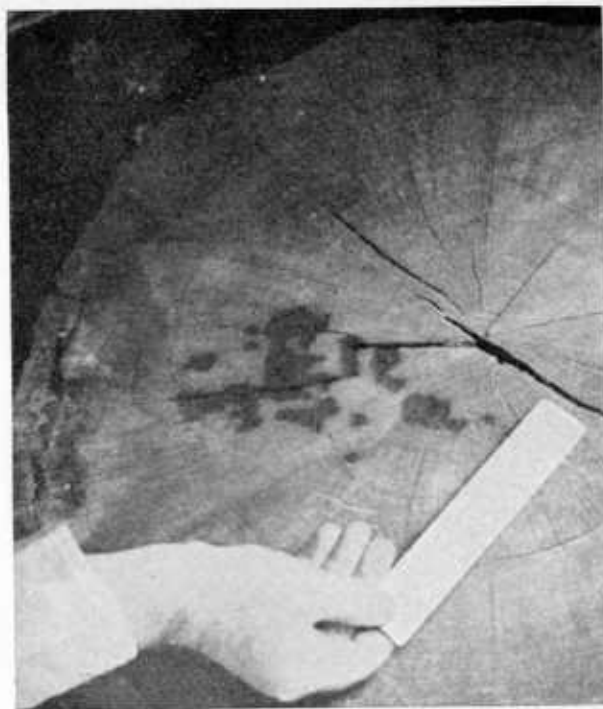
FIGURE 37.—Double pith.

### Grease Spots

*Definition.*—Grease spots are limited but conspicuous shadowy areas with a dirty “greasy” look (fig. 38). They are black, brown, or green in color. The wood appears to be impregnated with a dirty oil.

*Occurrence.*—Grease spots occur principally in chestnut and overcup oak and very occasionally in cow and white oak. They are generally found in timber on poor sites or with a bad fire history. In overcup oak, they may be related to very small pin worm damage.

*Significance.*—*In factory logs*, a small number of grease spots may be disregarded. A conspicuous con-



F-455608

FIGURE 38.—Grease spot.

centration<sup>4</sup> of grease spots that prevents the lumber from reaching the highest grade it would otherwise be qualified for is considered a defect. *In tie and timber and local-use logs*, grease spots can be disregarded.

### Grub Channels

*Definition.*—Grub channels are round holes or irregular channels of varying length, from  $\frac{3}{8}$  inch to 1 inch wide (fig. 39). They are the result of wood-consuming grubs that hatch from eggs laid in the log or living tree and work their way to the surface. The holes are cross or longitudinal sections of the channels.

*Occurrence.*—A single hole or channel may show, or the end of the log may be literally riddled. Although grub channels may occur in any species, they are found most often in the oaks, particularly in overcup oak, chestnut oak, and the water oaks. As discussed under insect-caused overgrown abnormalities (p. 18), species-site relationships are important clues to their occurrence.

*Significance.*—When grub channels are not concentrated or when a concentration is confined to the heart

<sup>4</sup> Conspicuous concentration is defined as occupying, in any quarter of the log, more than one-half the area between the heart center and the bark.



F-455609

FIGURE 39.—Grub channels.

center, grub channels may be disregarded in *factory logs*. Careful search, including thorough examination of the surface, should be made to be sure that the concentration is so confined. When it is not, it is a defect. In extreme cases, and when found in conjunction with other defects, grub channels may cause complete culling of the log. In *tie and timber logs*, concentration of grub channels in any portion of the log is a defect. Grub channels can be ignored in *local-use logs*.

### Gum Spots

**Definition.**—Gum spots are accumulations of gum-like substances occurring as small patches, streaks, or pockets. They may be related to bird peck or other injury to the growing wood, or as in sweetgum, may be simply impregnations of the wood fibers, related to physiological disturbances.

**Occurrence.**—Gum spots are found chiefly in black cherry and sweetgum.

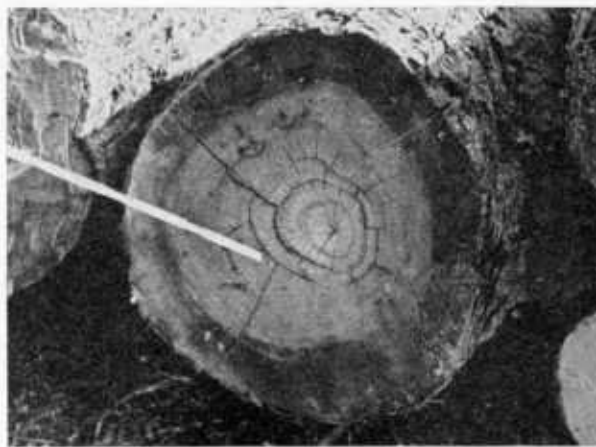
**Significance.**—In *factory logs*, gum spots are defects when found in conspicuous concentration, for they reduce otherwise higher grades of lumber. A few spots are admitted into clear cuttings and may be disregarded. Gum spots are not defects in *tie and timber logs* and *local-use logs*.

### Loose Heart

**Definition.**—Loose heart is the tangential separation of fibers along a growth ring at the heart center or core of the log, in an area generally not over 6 to 12 inches in diameter (fig. 40).

**Occurrence.**—Loose heart is likely to be found especially in pecan and honey locust, and in overcup, chestnut, scarlet, and the water oaks.

**Significance.**—The area affected is definite, and must be considered defective. When loose heart is confined to the heart center, it may be disregarded as a defect in *factory logs*. Although the volume yield will be greatly reduced through culling the affected section, the loose heart will in such cases have a minimum effect on average lumber grade yield. Loose heart prevents taking a *tie or timber* out of the center portion of the log, and is a defect in logs designed for this use. If the cull is not too great, loose heart may be disregarded in *local-use logs*. Frequently, loose heart derives from the release of crooked, suppressed



F-455610

FIGURE 40.—Loose heart.

saplings and follows the original stem form. Thus, it may have a disastrous effect on small, crooked, or sweepy logs, often necessitating complete culling.

### Mineral Streak (Mineral Stain)

**Definition.**—Mineral streaks and stains are abnormal discolorations—black, blue, brown, or olive-green—usually in variegated or streaky patches (fig. 41).

**Occurrence.**—They are very conspicuous in soft maple, hard maple, yellow-poplar, willow, and the magnolias. They are found generally throughout the oaks, especially the water oaks, and particularly on poor sites.

**Significance.**—In *factory logs*, they are a defect when in conspicuous concentration outside the heart center. A small amount may be disregarded. In the maples and magnolias and in yellow-poplar, mineral stain itself is not a lumber defect. Heavy concentrations, however, are usually associated with fine check



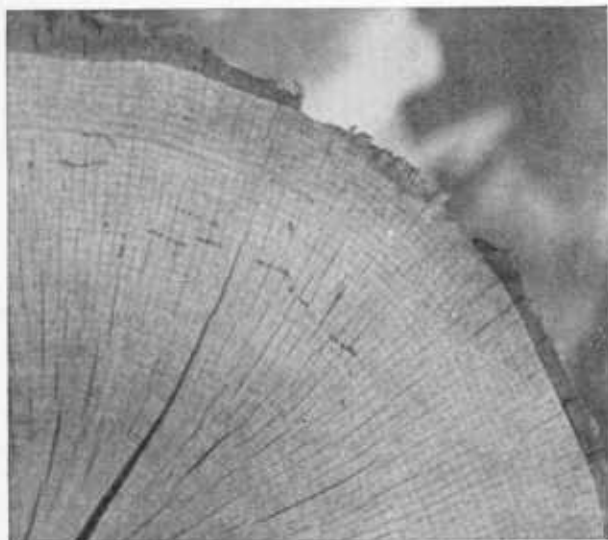
F-455611

FIGURE 41.—Mineral streak and stain.

and shake, which are defects. Mineral streak and mineral stain can be disregarded in *tie and timber* and *local-use logs*.

### *Pin Worm Holes*

**Definition.**—These are small round holes, always somewhat less than one-sixteenth inch in diameter (fig. 42). Certain types are exceedingly minute. Those found in some species, notably overcup oak, are



F-455612

FIGURE 42.—Pin worm holes.

so small that they could easily be overlooked if it were not for accompanying faintly discolored threads or spots.

**Occurrence.**—They are most prevalent in, but not confined to, post oak, soft maple, overcup and chestnut oaks, ashes, and yellow birch. Black cherry, elms, hickories, pecan, yellow-poplar, beech, sweetgum, tupelo, magnolias, cottonwood, and willow are relatively free. When pin worm holes occur, they are invariably numerous; practically all of the wood in the log will be affected.

**Significance.**—In *factory logs*, pin worm holes are defects. As with spot worm, special grades of lumber with lowered value are used for the species in which occurrence is most common. Pin worm holes may be disregarded in *tie and timber* and *local-use logs*.

### *Ring Shake*

**Definition.**—Ring shake is a tangential separation of the wood fibers along the annual rings (fig. 43).



F-455614

FIGURE 43.—Ring shake.

Sometimes it is confined to definite sections along the outer rim of wood, sometimes it is confined to the center, and sometimes it is found all through the log. Important ring shake is often so fine as to be invisible in green wood, and shows up only when the wood is dry.

*Occurrence.*—Although ring shake is definitely related to species, it is not found on all trees of any species. On the other hand, it may be found in some trees of every species. It seems especially prevalent in overmature, leaning, and sweepy timber. A serious butt injury to a tree may lead to ring shake. As good second-growth timber stands develop, the occurrence of ring shake will be greatly reduced. Today, however, much of the old-growth bitter pecan is shaky. Ring shake is also serious in sycamore, tupelo, elms, and overcup and chestnut oak.

*Significance.*—In *factory logs*, ring shake confined to the heart center or to definitely localized areas in the periphery can be sealed out. Ring shake confined to the heart center is not a defect, but peripheral ring shake is a defect because it will stop cuttings. When ring shake is general throughout the log, it is a good reason for complete culling. It is a defect in *tie and timber logs*. Localized shake can be disregarded in *local-use logs* up to the point where the cull deduction for it exceeds that permitted in the class.

### Rot

*Definition.*—Rot is an advanced stage of decay in which the structure of the wood has been broken down and its usefulness ruined (fig. 44).

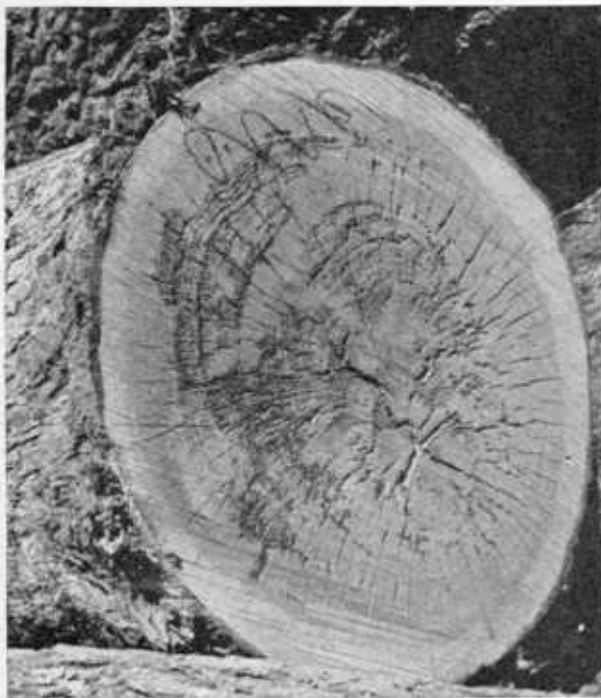


FIGURE 44.—Rot.

*Occurrence.*—There is no particular relationship to species. Rot generally occurs in definite areas. A frequent location is the center of the tree or log. Other rotten areas resulting from wounds or knots are found in the outer rim of wood.

*Significance.*—The significance varies with use and location. In *factory logs*, rot confined exclusively to the heart center can be overlooked as a log defect. The affected section will, of course, be culled out in the scaling. Even though they are sealed out, peripheral rotten areas are log defects if they occupy over one-half the cross-sectional area in any quarter between the heart center and the bark.

In *tie and timber logs*, center rot is a defect which, except in large diameters, probably will eliminate the log from the class. Peripheral rot is also a defect, unless it is so superficial that it will extend into the included tie or timber in only a few minor spots which are not more than 3 inches deep. In *local-use logs*, rot can be disregarded as a log defect provided the cull deduction does not exceed the limits for the class.

### Shot Worm Holes

*Definition.*—Shot worm holes are clean-cut round holes about one-eighth inch in diameter (fig. 45). They are generally concentrated in and about doty or rotten heartwood, especially open butt wounds.

*Occurrence.*—They are commonly found in oaks, hickories, ashes, and occasionally in sweetgum heartwood.

*Significance.*—Since shot worm holes are generally associated with rotten wood, they are not a defect in *factory logs* if confined to the cull section. However, if they extend beyond the bad section and increase the area to be culled, they become log defects. They can be disregarded in *tie and timber* and *local-use logs* if the allowance for associated cull is adequate.

### Soak

*Definition.*—Soak is a moderately discolored area, dirty mustard yellow, bleached brown, or dull gray in color. The wood looks dull, dead, rough, and spongy, and often water-soaked or weathered. Although it is considered by some as incipient decay, soak actually is not accompanied by a softening of the fibers; sometimes, in fact, they may be embrittled.

*Occurrence.*—It is most common in overcup and water oaks on poor sites.

*Significance.*—Ordinarily, no cull deduction is made for soak. In *factory lumber*, it is regarded as equal



FIGURE 45.—Shot worm holes and associated rot.

in effect to mineral stain or localized slight dote. When heavy enough to be so considered, soak becomes a *factory log* defect, but can be disregarded in *tie and timber* and *local-use logs*.

### *Spider Heart*

*Definition.*—Spider heart is a multiple radial separation of the wood fibers starting at the pith center and running out in at least three directions (fig. 46).

*Occurrence.*—Spider heart is related to species, size, and degree of maturity. It is common in scarlet, overcup, and water oaks, and is likely to be found in chestnut oak. The most important occurrence is in large, fully mature or overmature trees.

*Significance.*—Spider heart will ruin the products in which it occurs. If it is confined to the heart center, it is not a defect in *factory logs* and in *local-use logs*. When it extends beyond the heart center in *factory logs* and when it occurs to any degree in *tie and timber logs*, it is a log defect.



FIGURE 46.—Spider heart.

### *Spot or Flag Worm Holes*

*Definition.*—Spot or flag worm holes are clean-cut holes about one-thirty-second to one-sixteenth inch in diameter, typically occurring in pairs (fig. 47). They are invariably surrounded by an oval or elongated stained or (in oaks and elms) bleached area or "flag."

*Occurrence.*—In red and silver maple and post oak, spot worm will be found in almost every tree over the entire range of the species, but intensity will vary from tree to tree. In soft elm, beech, chestnut oak and white oak, occurrence is spotty and some localities are entirely free. White oak over most of its range is free, but damage is likely to be found on sites which are dry or lacking in lime.

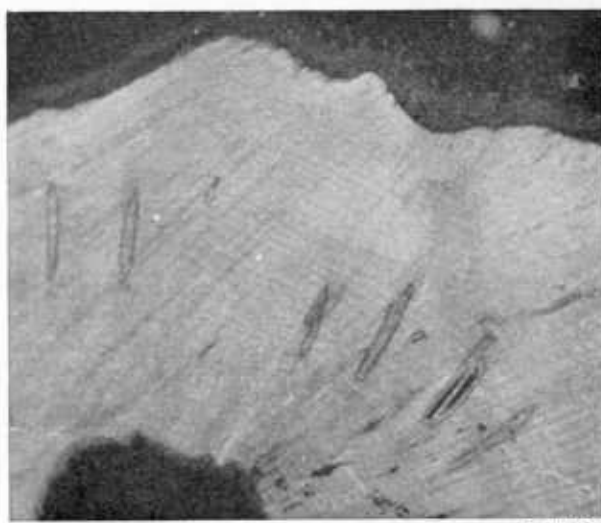


FIGURE 47.—Spot or flag worm holes.

*Significance.*—In factory logs, spot worm holes with their accompanying flags are defects except in heavily damaged oaks and maples. In these species, the lowered value of such lumber is recognized by special grades and the holes need not be considered as log defects when utilization practice is to use such grades (WHND: worm holes no defect). Spot worm can be disregarded in tie and timber and local-use logs.

### Wind Shake

*Definition.*—Wind shake is a single radial split extending to both sides of the pith (fig. 48). Sometimes it is confined to the heart center, but often it will go to the perimeter of the heartwood. Damage is usually most serious in butt logs, but many times the split extends the entire length of both the butt and upper logs.

*Occurrence.*—Wind shake is most serious in black oak, southern red oak, scarlet oak, and northern red oak growing on upland sites in the south central United States west of the Mississippi River. It is more prevalent in older trees than in the younger ones, and it is possible that, as site conditions improve and good second-growth timber stands develop, the occurrence will be greatly reduced. Wind shake is also found in some of the white oaks, particularly chestnut oak, on upland sites throughout the Appalachian region and the remainder of the South. It becomes serious along about the middle of slopes and is worst on the ridge tops.



F-456029

FIGURE 48.—Wind shake.

*Significance.*—In factory logs, wind shake can be scaled out, and that which is confined to the heart center is not a defect. Where it extends to the perimeter of the heartwood in logs where the sapwood band is narrow, it is a defect because it will stop cuttings. Most wind shake is so serious that it disqualifies the log for a tie or a timber log. Wind shake may be disregarded in local-use logs unless it is severe enough to cause the log to split open in handling.

## GENERAL APPEARANCES WHICH WARN THAT LOG DEFECTS SHOULD BE SOUGHT

Thus far, the discussions have been concerned with specific features of logs which, if properly identified and evaluated, are guides to accurate log appraisal. Sometimes, however, a log or tree can be evaluated by general appearances, or warning signs may herald the presence of specific log defects.

### Signs in Standing Timber

There is a definite relationship between timber quality and site condition or past history of the stand. Poor site, past fire damage, and overmaturity are often clues to the presence of such defects as insect damage, shake, or stain.

General condition and appearance of individual trees in any given locality serve either as a specific guide to lumber defects which have no other outward indication of their presence (shake or mineral stain, for example), or as a warning to intensify search for important log defects (such as bark distortions) which cannot be seen at a glance. To appraise basic differences in appearance of standing timber requires training and familiarity with each species over a wide range of conditions. But keen observation and practice will enable one to determine and recognize the characteristics of sound, healthy trees, and, by comparison, those of trees likely to be defective.

Obvious clues to decadence are stagheadedness, bad fire scars, and large, open wounds. Less conspicuous but of the same nature are dry tops, dead limbs, healed scars, and rotten knot holes, often overgrown except for a gaping, oozing center. Such features indicate decadent timber which may carry par-

evidence of lack of vigor (dead limbs, thin top, and poor foliage), are among these (fig. 49).

In general, abnormally dark or abnormally light bark is a bad sign. In hickories and cherrybark oak and the water oaks, early stages of deterioration are evidenced by a darkening of the bark, usually accom-



F-455618-20

FIGURE 49.—Good, medium, and poor conditions of three willow oak trees, as indicated by bark characteristics.

ticularly the inconspicuous defects and unheralded ones like stain and spot worm. When such gross features occur, defects are very likely to be present in damaging proportions. Evidence of such defects in the form of small overgrowths, often partially hidden under extended but broken bark scales, will generally be plentiful and easily located upon close examination.

In addition to the gross features indicating decadence, less obvious general appearances are very important signs of probable defects. Color, thickness, and configuration of bark, particularly if coupled with

panied by a thickening and roughening. In extremely advanced stages of deterioration, the color trend in these species reverses, and the bark bleaches out to a dead, light gray and scales off to some extent. In species with bark normally soft and corky, such as yellow-poplar and sweetgum, the darkening is accompanied by a "plating" and smoothing out of the bark. On the other hand, defective white oak timber in all stages of deterioration is indicated by a lightening of color and a thinning and scaling off of bark. In all species, bark looks dry and lifeless when vigor is lost. Where such conditions attract attention, close

inspection is necessary if important log defects are not to be overlooked. The relation of timber condition to appearance is definite, and sometimes so extreme and positive that an experienced observer has no difficulty in appraising the degree of deterioration solely on this basis.

However, poor general appearance of bark is not an absolute indication of defect of any specific kind. Yellow-poplar, sweetgum, basswoods, and tupelos are rarely subject to insect attack (yellow-poplar in some localities is apt to be severely attacked by ambrosia beetles, the damage being referred to at times as spot worm, grease spots, black hole, calico poplar). In these species, poor bark appearance generally indicates slow growth or approaching maturity, or, if localized, a cull section. In fact, an area of poor bark in these species is as good a sign of cull as a butt or stem bulge.

On the other extreme are the oaks and the hickories. Here poor appearance, although also a sign of lower vitality, does not reliably indicate specific location or extent of cull. It is, however, almost an invariable clue to hidden or obscure bark distortions. Close inspection of the bark of poor trees of these species will often reveal scattered, medium-size, dry holes that penetrate the bark scales but do not lead into the wood. It will also reveal that any abnormal roughening is due to numerous horizontal breaks or cracks in the bark ridges or scales. In the bark cracks and under the scales containing the holes will generally be insect-caused log defects (fig. 50). In most cases, other log defects will have been noted before the examination has gone that far.

In other species, such as sycamore, and the ashes and maples, the significance of bark appearance is quite variable. In all species, however, poor or abnormal appearance should lead to intensive search for log defects.

At least two types of local bark discolorations deserve notice. One is the so-called "tobacco juice" exudation—a small, usually damp, dark brown spotch with a drying gray border, found up and down the bole. It is unmistakable evidence of fresh insect damage which can be disregarded unless the splotches are very numerous or are accompanied by bark distortions typical of long-established infestations.

The other type of local discoloration is a large patch or streak running down the stem and originating at a broken top or an open wound or knot hole in the main

stem. When coming from a broken or hollow top of the major stem, the discoloration is usually an overflow of rain water. When the discoloration originates elsewhere than in the top, it is caused by water seeping from a pocket of decay. However, the mere fact that it is seeping or running usually indicates that decay is not far advanced, or at least that the cull section is not an extensive hollow. Ordinarily, the decay will not pass the next lower fork or body node. However, when such a situation is found on the merchantable stem, it is a log defect if not cut out.



F-455621-22

FIGURE 50.—In the oaks and hickories, holes like this one (left) call for careful search for the actual defect. The hole was made by an emerging grub, and beneath the scale (right) is the overgrown evidence of his presence.

### *Signs on End of Log*

The lumber defects underlying surface abnormalities (log defects) sometimes show up in the end of the log. This fact is particularly useful where logging operations have scraped the log so that overgrowths, in particular, are hard to find. If the previous inspection has not found surface indication of the associated lumber defects, grub channels and bark pockets in the end of the log call for a recheck of the surface. The ends of very large logs may give positive indication of heavy insect infestation, the external signs of which have been overgrown so long as to be obliterated. In such cases, because the affected area outside of the heart center represents such a large part of the high-grade lumber, the exposed defects themselves must be evaluated in appraising quality. Otherwise, such end features merely warn that a recheck should be made.

# CLASSIFICATION AND EVALUATION OF LOG ABNORMALITIES

## *Classification*

It has been shown that certain abnormalities which indicate wood blemishes may be disregarded as log defects under certain conditions in any type of log, and that some may never be disregarded. The latter group needs no further definition; the first, however, requires some explanation.

In standing timber, an abnormality may be disregarded if it will not be included in the logs that are cut out.

Size and character of the abnormality are other important conditions, particularly in tie logs. Concentration is another factor important in judging significance, particularly of end defects, and especially in factory logs. Position of defect within the log is another consideration. This works two ways. Defects and imperfections confined to the heart center of factory logs are minimized; in tie and timber logs, they are maximized, particularly in small and medium diameters. In local-use logs there are few degrading or disqualifying defects as in other logs. The important items are unsound scalable defects which are taken into account only in the aggregate to determine net scale and which, if excessive, disqualify the log.

Table 1 classifies the defects that have been discussed on the preceding pages.

## *Evaluation*

Heretofore, each defect has been discussed independently in relation to potential use of piece, but not in relation to other defects. The implication may have been that each defect bears equal weight as a quality determinant; i. e., a small knot is equal to a large knot; a large knot is equal to a seam; a seam is equal to a burl; and a burl is equal to a concentration of grub channels in the end. With local-use logs, this question is unimportant because there are so few significant log defects.

For tie and timber logs, the implication that one defect is of equal weight with another will also probably hold, for the major influence of log defects ap-

pears to be either to admit or exclude the logs from the class. For example, the effect of an extremely large knot or of loose heart would be equal in that either would render the log unsuitable for tie and timber use.

In factory logs, however, the situation is less simple. Here the primary effect of defects is to limit clear cuttings. A secondary effect is directly to degrade boards which, without the particular blemishes, would be of higher grades. Relation of defects to log size is important because it is common practice to eliminate or segregate lumber defects in wide boards by ripping. The effect of blemishes can be minimized in this way if the resulting boards are within the width limit for the grade specified in the rules (see appendix, p. 35).

In principle, a very tiny knot is equal in degrading effect to a large knot. However, a run of factory logs may yield enough wide boards, from which small knots can be ripped out, so that the mere presence of the knots in the log may not actually mean low-grade boards. Because of this possibility, it may be necessary, in logs of large diameters, to discount log defects which indicate very small knots, whereas full weight may have to be given to large knots in logs of all sizes. Other defects in factory logs may have the effect of degrading all of the lumber in the log to a very low point. Slight bird peck, for instance, might be disregarded as a defect in logs otherwise defect-free. If, however, bird peck were very heavy, the procedure might be to give it the ultimate significance and consider that even in the absence of all other log defects, the bird peck would relegate the log to the lowest factory grade, if not to a lower class.

It is obvious, however, that the basis for evaluation of defects, i. e., whether their effect is partial or full, or whether they are considered individually or en masse, must lie in a log grading system which will not only evaluate individual log defects, but will also relate them to the distribution or size requirements of the product specification and to the other major quality determinants such as size, crookedness, or position of the log in the tree. Such a system will also segregate the various use classes and thus give a basis for judging whether abnormalities are or are not log defects.

TABLE 1.—*Classification of log abnormalities*

## LOG SURFACE ABNORMALITIES

Abnormalities	Factory logs	Tie and timber logs	Local-use logs
Adventitious bud clusters.....	Defect.....	No defect.....	No defect.
Bulges:			
Butt.....	(1).....	(1).....	Do.
Stem.....	(1).....	(1).....	Do.
Bumps:			
High.....	Defect.....	(2).....	(2).
Low.....	(8).....	(8).....	(2).
Burl.....	Defect.....	Defect.....	(2).
Butt scar.....	(1 <sup>4</sup> ).....	(1 <sup>4</sup> ).....	No defect.
Butt swell.....	No defect.....	No defect.....	Do.
Canker.....	(1).....	(1).....	Do.
Conk.....	Defect.....	Defect.....	Do.
Flanges.....	No defect.....	No defect.....	Do.
Flutes.....	(4).....	(4).....	Do.
Fork.....	(1).....	(1).....	Do.
Holes:			
Large.....	Defect.....	(5).....	(2).
Medium:			
Ant, fresh.....	No defect.....	No defect.....	No defect.
Ant, old.....	Defect.....	do.....	Do.
Birds, light.....	No defect.....	do.....	Do.
Birds, heavy.....	Defect.....	do.....	Do.
Grub.....	do.....	do.....	Do.
Increment borer.....	do.....	do.....	Do.
Tap.....	do.....	do.....	Do.
Small.....	(4).....	do.....	Do.
Knots:			
Sound.....	Defect.....	(2).....	(2).
Unsound.....	do.....	(5).....	(2).
Limbs.....	do.....	(2).....	(2).
Overgrowths:			
Knots and bark pockets.....	do.....	(2).....	No defect.
Insects.....	do.....	No defect.....	Do.
Bird peck.....	do.....	do.....	Do.
Bark distortions.....	do.....	do.....	Do.
Seams.....	(4).....	(4).....	Do.
Splits.....	(4).....	(4).....	Do.
Surface rise.....	No defect.....	No defect.....	Do.
Wounds:			
New.....	do.....	do.....	Do.
Old.....	(4).....	(4).....	Do.

## LOG END ABNORMALITIES

Dote.....	(6).....	Defect.....	No defect.
Double pith.....	(1).....	(1).....	Do.
Grease spots.....	(7).....	No defect.....	Do.
Grub channels.....	(7).....	(7).....	Do.
Gum spots.....	(7).....	No defect.....	Do.
Loose heart.....	(6).....	Defect.....	Do.
Mineral streak and stain.....	(7).....	No defect.....	Do.
Pin worm holes.....	Defect.....	do.....	Do.
Rot.....	(6).....	Defect.....	Do.
Shake:			
Ring.....	(6).....	do.....	Do.
Wind.....	(6).....	do.....	Do.
Shot worm holes.....	Defect.....	No defect.....	Do.
Soak.....	(7).....	do.....	Do.
Spider heart.....	(6).....	Defect.....	Do.
Spot or flag worm holes.....	Defect.....	No defect.....	Do.

<sup>1</sup> Defect if not cut off.<sup>2</sup> Defect if large.<sup>3</sup> Defect if certain species involved.<sup>4</sup> Defect if not superficial.<sup>5</sup> Defect if large and deep.<sup>6</sup> Defect if not confined to heart center.<sup>7</sup> Defect if concentrated.

## APPENDIX

TABLE 2.—*Basic specifications for standard hardwood lumber grades*

[Adapted from the rule book of the National Hardwood Lumber Association, Chicago, January 1949. Published by permission of the National Hardwood Lumber Association.]

Grade	Minimum requirements				
	Length <sup>1</sup>	Width	Yield of rough lumber in clear-face cuttings	Size of cuttings	Cuttings <sup>2</sup>
	<i>Feet</i>	<i>Inches</i>	<i>Percent</i>		<i>Number</i>
Firsts and seconds.....	8	6	83⅓	4' x 5' or 3' x 7'.....	1-4.
Selects <sup>3</sup> .....	6	4			
1 Common.....	4	3	66⅔	4' x 2' or 3' x 3'.....	1-5.
2 Common.....	4	3	50	3' x 2'.....	1-7.
Sound wormy <sup>4</sup> .....					
3A Common.....	4	3	33⅓	3' x 2'.....	No limit.
3B Common.....	4	3	5 25	1½' x variable length....	To give 36 square inches.

<sup>1</sup> Percentage of short lengths limited by grades; e. g., in firsts and seconds, only 15 percent can be 8 feet to 9 feet; in 2C, 10 percent can be 4 feet to 5 feet.

<sup>2</sup> Number varies with surface measure (s. m.) of piece; e. g., 1C with s. m. of 5 feet to 7 feet, 2 cuttings allowed; in 1C with s. m. of 11 feet to 14 feet, 4 cuttings allowed.

<sup>3</sup> Better face is seconds; reverse side of cuttings sound. Better face is seconds; reverse side of board No. 1 C.

<sup>4</sup> Full log yield of 1C and Better, with worm holes, knots, etc., not over ¾ inch and stain, admitted into cuttings.

<sup>5</sup> Sound cuttings. Lumber is suitable for low-grade crating and dunnage.

### *Indications of Deterioration in Dead Timber or Stored Logs*

Since timbermen frequently are concerned with dead trees, or with logs which have been left in the woods or stored for a lengthy period, it is important to discuss briefly the indications of deterioration found in such material, so that they can be distinguished from those found on live trees or freshly cut logs.

Hardwood logs, particularly in the southern lowlands, are highly susceptible to deterioration through the action of insects and fungi. In summer, logs left more than 2 weeks begin to deteriorate so rapidly that even "hot logging" will not keep some species from damage. Operations for hickory and persimmon for dimension specialties are frequently suspended in late spring and early summer because of borer activity. For all other species, hot logging is a necessity during this period. In the deep South, insects may cause damage the year round.

Among the first to infest logs are the ambrosia beetles. They start working almost at once in the sapwood, on the ends, or on spots where the bark has been knocked off. Later, they may also go through the bark and attack the remaining sapwood and sometimes the heartwood. Their holes are so very small that it is easier to spot a pile of flour-like "frass" than to see the

holes themselves. Ambrosia beetles are particularly bad in sweetgum, maples, oaks, and yellow-poplar. Their work degrades the lumber. Like shake, any indication of it ("worms" in the trade) generally renders a shipment suspect in the eyes of the buyer, and puts the seller in an awkward position.

Another insect, especially bad in the ashes and hickories, pecan, and persimmon, is the round-headed borer. The grub of this insect causes degrade and often outright culling by making medium-sized holes throughout the wood.

Stain-causing fungi come simultaneously with, and some are introduced by, the ambrosia beetles. The first effect is a rather even sooty blue-gray or black discoloration of the wood. Later, a felty surface may develop. Stain proceeds from the ends and through wounds. It does not develop rapidly under bark. In early stages, stain does not degrade lumber, although it affects its salability. In later stages, it definitely degrades lumber unless stain is specifically permitted by the grading rules.

After stain come "flowers." These are whitish, yellowish, brownish, or grayish variegated mosaic efflorescences, usually though not necessarily superimposed on the stain. They are evidence of a separate fungus which causes decay. Since they are commonly accompanied by light mustard-colored or gray

bleached streaks in the wood, flowers are, in the trade, considered as the beginning of dote and will not be admitted into cuttings. It is general practice to trim 1 to 2 feet off the ends of boards cut from logs that show flowers and yellow streaks on the end. Although sweetgum and the tupelos are most susceptible to stain and flowers, sapwood of most species will be attacked. The water oaks are also hit hard.

On soft maple and on the hickories, elms, and hackberries, a fungus causing an inconspicuous internal dry rot starts quickly. This fungus gives no surface evidence of its presence until it has caused such advanced interior decay that the log is worthless. At this time, the wood is weak, yellowish, exhibits black, threadlike lines, and looks dry and bleached out. The surface of the log may still appear sound, and merely weathered. Other fungi betray their presence by fruiting bodies (toadstools and brackets). These generally indicate advanced dote and a high percent of cull, if indeed the log is usable at all (fig. 51).

The ends of any logs left out in the weather will check or split. The ashes, hickories, pecans, and overcup oak are prone to end-check throughout the year. In other species, degree of end-checking varies with the season. In good drying weather, end-checking in cottonwood, the pecans, the hickories, and the oaks is particularly bad. In general, end-checks are progressive, with the speed and severity related to rate of drying. In most logs of most species, they are not serious, for they generally go less than 1 foot into the log. On logs of susceptible species, they may extend well into

the center and cause serious damage. Such extreme checks are equal in effect to splits. The importance of checks is also related to log size. Small logs may be completely ruined by checks which in larger logs would be unimportant.



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FIGURE 51.—Brackets are a sign that rot has made at least the sapwood useless. The heartwood may remain sound for a considerable time, but very careful examination is needed to determine how far decay has spread.

### *Common and Scientific Names of Species Referred to in the Text*

<i>Lumber or local name</i> <sup>1</sup>	<i>Recognized common name</i> <sup>2</sup>	<i>Scientific name</i> <sup>2</sup>
Ash.....	Green ash.....	<i>Fraxinus pennsylvanica lanceolata</i>
	White ash.....	<i>F. americana</i>
Basswood.....	Basswood; linden <sup>3</sup> .....	<i>Tilia</i> spp.
Beech.....	American beech.....	<i>Fagus grandifolia</i>
Birch, yellow.....	Yellow birch.....	<i>Betula lutea</i>
Blackgum.....	Black tupelo; blackgum.....	<i>Nyssa sylvatica</i>
Blackgum, swamp.....	Swamp tupelo; swamp black tupelo <sup>3</sup> ....	<i>N. sylvatica biflora</i>
Cherry.....	Black cherry.....	<i>Prunus serotina</i>
Cottonwood.....	Eastern cottonwood; eastern poplar <sup>3</sup> ....	<i>Populus deltoides</i>
Cottonwood, swamp.....	Swamp cottonwood; swamp poplar <sup>3</sup> ....	<i>P. heterophylla</i>
Elm, soft.....	American elm.....	<i>Ulmus americana</i>
Elm, cedar.....	Cedar elm.....	<i>U. crassifolia</i>

See footnotes at end of table.

*Common and Scientific Names of Species Referred to in the Text—Continued*

<i>Lumber or local name</i> <sup>1</sup>	<i>Recognized common name</i> <sup>2</sup>	<i>Scientific name</i> <sup>2</sup>
Hackberry.....	Hackberry; common hackberry <sup>3</sup> .....	<i>Celtis occidentalis</i>
	Sugarberry; sugar hackberry <sup>3</sup> .....	<i>C. laevigata</i>
Hickory.....	Hickory.....	<i>Carya</i> spp.
Honeylocust.....	Honeylocust; common honeylocust <sup>3</sup> .....	<i>Gleditsia triacanthos</i>
Magnolia.....	Magnolia.....	<i>Magnolia</i> spp.
Maple, soft.....	Red maple.....	<i>Acer rubrum</i>
	Silver maple.....	<i>A. saccharinum</i>
Maple, hard.....	Sugar maple.....	<i>A. saccharum</i> <sup>3</sup>
Oak, black.....	Black oak.....	<i>Quercus velutina</i>
Oak, burr.....	Bur oak.....	<i>Q. macrocarpa</i>
Oak, cherrybark.....	Cherrybark oak <sup>3</sup> .....	<i>Q. falcata leucophylla</i> <sup>3</sup>
	Swamp red oak.....	<i>Q. falcata pagodaefolia</i>
Oak, chestnut.....	Chestnut oak.....	<i>Q. montana</i>
Oak, chinquapin.....	Chinkapin oak.....	<i>Q. muehlenbergii</i>
Oak, cow.....	Swamp chesnut oak.....	<i>Q. prinus</i>
Oak, Delta post.....	Post oak.....	<i>Q. stellata</i>
Oak, forked-leaf white.....	White oak.....	<i>Q. alba</i>
Oak, laurel.....	Laurel oak.....	<i>Q. laurifolia</i>
Oak, northern red.....	Northern red oak.....	<i>Q. borealis</i>
Oak, Nuttall.....	Nuttall oak.....	<i>Q. nuttallii</i>
Oak, obtusa.....	Diamondleaf oak.....	<i>Q. obtusa</i>
Oak, overcup.....	Overcup oak.....	<i>Q. lyrata</i>
Oak, pin.....	Pin oak.....	<i>Q. palustris</i>
Oak, post.....	Post oak.....	<i>Q. stellata</i>
Oak, scarlet.....	Scarlet oak.....	<i>Q. coccinea</i>
Oak, shingle.....	Shingle oak.....	<i>Q. imbricaria</i>
Oak, Shumard.....	Shumard oak.....	<i>Q. shumardii</i>
Oak, southern red.....	Southern red oak.....	<i>Q. falcata</i>
Oak, swamp white.....	Swamp white oak.....	<i>Q. bicolor</i>
Oak, turkey.....	Turkey oak.....	<i>Q. laevis</i>
Oak, water.....	Water oak.....	<i>Q. nigra</i>
Oak, willow.....	Willow oak.....	<i>Q. phellos</i>
Pecan, sweet.....	Pecan.....	<i>Carya illinoensis</i>
Pecan, bitter.....	Water hickory.....	<i>C. aquatica</i>
Sapgum.....	Sweetgum.....	<i>Liquidambar styraciflua</i>
Sycamore.....	American sycamore.....	<i>Platanus occidentalis</i>
Tupelo.....	Water tupelo.....	<i>Nyssa aquatica</i>
Walnut.....	Black walnut.....	<i>Juglans nigra</i>
Willow.....	Black willow.....	<i>Salix nigra</i>
Yellow-poplar.....	Yellow-poplar; tuliptree <sup>3</sup> .....	<i>Liriodendron tulipifera</i>

<sup>1</sup> According to local usage.

<sup>2</sup> According to "Check List of the Native and Naturalized Trees of the United States, Including Alaska." U. S. Forest Service, Washington, D. C. 325 pp. Rev. ed. 1944.

<sup>3</sup> According to "Standardized Plant Names," by H. P. Kelsey and W. A. Dayton for Amer. Joint Com. on Hort. Nomencl. J. Horace McFarland Co., Harrisburg, Pa. 675 pp. 2d ed. 1942.









